POWER PLANT ENGINEERING

VOL. XXXVI CHICAGO, JUNE 1, 1932 No. 11

Contents of this Issue

Page

WITH THE EDITORS....442

SUGGESTIONS FOR PROFITABLE READING....443

ENGINEERING AND CONSTRUCTION SCHEDULES. By H. W. Fuller and W. B. Rittenhouse....444

POOLING OF POWER. By Guy B. Randall....449

EFFECT OF REDUCED LOAD ON DIESEL OPERATING COSTS....452

LANDSCAPING, A POWER PLANT PROBLEM. By Oakley V. Morgan and James H. Burdette....454

PIPE HANGERS AND SUPPORTS USED IN MODERN FABRICATION. By Henry C. Moffett....457

STEAM TRAPS IN INDUSTRIAL PLANTS. By T. H. Rea....459

FLEXIBLE COUPLING LUBRICATION....461

UNDERSIZE WIRING....462

REDEVELOPMENT OF ROANOKE RAPIDS. By Alan G. Cherry....463

OFF DUTY....465

READERS' CONFERENCE: FLOW METERS WITH VARIABLE CAPACITY. DID THE GENERATOR REVERSE? EMERGENCY PUMP REPAIR JOB. AIR COMPRESSOR EXPLOSION. BOILER TUBE REPAIR RECORD. PRECAUTION IN REASSEMBLING DUPLEX PUMPS....466

NEW WATER METER....469

WIZARD PILOT UNIT....469

NEW COPES FEEDWATER REGULATOR....469

FAUCET FOR HEAVY MIXTURES....469

NEW FORCE FEED LUBRICATOR....470

PORTABLE PIPE MACHINE....470

SPLIT PHASE MOTOR....470

A. S. R. E. TO MEET IN CAMBRIDGE....470

NEWS FROM THE FIELD....471

FOR THE ENGINEER'S LIBRARY....472

POWER PLANT CONSTRUCTION NEWS....473

Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index, on file in public libraries.

EDITORIAL STAFF

ARTHUR L. RICE, Editor
R. E. TURNER, Managing Editor
A. W. KRAMER, Associate Editor
CHESTER R. EARLE, Associate Editor
RICHARD H. MORRIS, Associate Editor

Published on 1st and 15th of each month, copyright 1932, by the

Technical Publishing Co., 53 West Jackson Blvd., Chicago

New York Office, 171 Madison Avenue

Subscription price: U. S. A. $2 a year; other countries $4 a year. Single copy current issue: U. S. A. 15c, other countries 25c; except January 1st issue U. S. A. 50c, other countries 60c. Single copy back issue: U. S. A. 25c, other countries 35c; except January 1st issue U. S. A. 75c, other countries 85c.

Member, Associated Business Papers, Audit Bureau of Circulations.

Circulation of this issue 23,200

What's Wrong Here?

SOME DAY when you are in the mood for wondering what it's all about, drop off the train at American Falls, Idaho, and walk along the bank of the reservoir towards the wonderful hydroelectric plant that supplies electric power for that section of the state. Quite likely you will get a view nearly identical with the picture above. Then your mental processes will begin to work and you will begin to doubt your own eyes for the whole thing seems wrong—like one of those what's-wrong-here pictures—and you wonder if somebody is not playing a joke on you; for here in the middle of the lake are trees in formal rows and squares and they are not the kind of trees that you are accustomed to see in the middle of a lake. Then, too, here is what you would expect to be the hydraulic surge tank of the power plant but a mile or more above the dam where no respectable surge tank would think of being—and made of concrete, entirely unconventional; howbeit, there it is.

If, in bewilderment, you seek information from the first native you see, you get an earful about as follows: "Well, yer see, we wanted some 'lectricity to pump our iragatin' water and old Snake River had water and power, too, that she didn't know what to do with, so we just stretched a dam across her and tuck em both away frum her. Then we found the old river wouldn't stay 'way from our doors, so we moved the whole town back upon the hill there. Course we didn't move the trees er the grain elevator nur a lot of no 'count houses. Then we left some Hammermill Bond paper down thar to test it out scientifically. Oh, it showed up fine after six years but you're all wrong about that surge tank."

Now, while you are wondering about reservoirs and pools as they are used for power purposes, Mr. Randall's views on the subject, as told on page 449, may dovetail in with your own to form a picture as attractive as the one reproduced above.

WITH THE EDITORS

Cut Down Overhead

Only discouragement can result in trying to carry as a charge on present output the overhead on twice the plant needed for that output. Excess capacity can only be written off as a loss due to past bad judgment. The excessive investment may have been due in some instances to overgrown ambition to cover a national market when the product and organization were adapted for only a limited territory. In other cases the possible market was overestimated; in still others a product became a pet project of the manufacturer and expansion was pushed with little consideration as to possible demand. In any case, unless careful analysis shows a probable profitable market within a reasonable period for full capacity of the plant, the excess capacity should be disposed of or converted to other uses, the loss written off and overhead reduced.

To get taxes, another excessive overhead, back to within reason appears to be most difficult. Unless political office holders can be convinced that the people whom they are supposed to represent are determined that government—federal, state and local—shall return to its proper job instead of acting as a sinecure for henchmen of politicians, a nurse to week-kneed industries and a cat's paw for ambitious reformers, we shall probably see mounting expenditure for favored localities, projects and regulative agencies, accompanied by efforts to devise new ways of taxing already overburdened business and wage earners, in order to provide pabulum for the hangers on at the political courts of cities, states and the nation.

The will to economize and to reduce the number of organizations and persons who feed at the public crib is, at the present time, the most important test of qualification of any office-seeker for the job he wants.

Even many governmental activities which may seem to serve a useful purpose should be abolished, unless they can be proved essential to the welfare of the majority of the people. A tax burden such as is estimated for 1932 of 30 per cent of the income of the country means strangulation of business and industry and discouragement of the efforts of individuals to make progress. Concerted effort to force tax reduction is vital to the recovery of industry.

Every government activity can find somebody to defend it—aside from those who are getting a good living out of it. Economy may dictate that activities which we as individuals think worthwhile are not for the best interests of the people as a whole. Then individual interest must give way to civic interest.

Overhead,—including taxes, charges on account of investment, excessive management charges—goes on regardless of the amount of product turned out and adds unduly to cost of production when output is low. By cutting overhead, not only are red ink figures made less formidable but the time will be hastened when red will change to black. Also, as business returns to normal, the black figures will be more satisfactory.

Helping Yourself

It is surprising what a wide awake engineer can do to better conditions in his plant, if instead of sitting around grumbling about what he has, he sets about bettering conditions. Sometime ago one of our subscribers wrote in that he was badly in need of additional capacity from his mixed pressure turbines. Generators had recently been rewound to give sufficient generator capacity but the turbines wouldn't carry the necessary load.

First a thorough study was made of the electric load of each department, reducing where possible and staggering peaks in others. Then they were allowed by the manufacturer and insurance company to raise the steam pressure 8 lb. They also found that the superheater header had some blank spaces which when filled raised the superheat 30 to 40 deg. F. Back pressure on the mill engines was increased to 4 lb. This increased back pressure seemed to have no effect on the engines as the steam per ton of output remained constant.

This is just one example of what can be done by conscientious careful planning and stopping up the leaks. Careful attention to details like this is what gives the management confidence in your judgment and ability so that when additional capacity is really needed, your recommendations will carry weight.

Little Wastes

With business flourishing, returns satisfactory and production high, small wastes and losses are seemingly of little importance and are often overlooked. While the immediate effect may not be serious, the possible saving by changes in methods and equipment, which can easily be financed in prosperous times, may make the difference which will avoid red ink figures when profits shrink in dull times. And it is in such times that financing the needed changes seems difficult.

If leaks have, unfortunately, not been stopped, it is all the more important that in times like the present they be plugged immediately. Saving little wastes is now essential. Changes, replacements and overhauling can be done at minimum expense. If they are put off until business revives, not only will their cost be increased but interference with production may cause further deferring. Meantime the losses will continue, right now when they can least be afforded and later when they will reduce profits and delay getting back to a satisfactory-return basis.

Maintenance of plant and methods in a condition for best economy is at all times the part of wisdom but is most essential when reduction of costs is vital to the recovery of business. Reorganization of plant and working routine now will eradicate the little wastes at the time they hurt most and will be the start toward maintaining that condition when business is again good so that in the future a lull in activity will not find those wastes hampering our efforts to "come back."

Suggestions for Profitable Reading

There Are Two Sides to Every Question

—The right side and the wrong side. We don't recall who first enunciated this startling bit of philosophy, it may have been Mr. Dooley, but it doesn't matter, Mr. Dooley will serve nicely. As philosophy, we never did think much of it, indeed to us not only is it unsound philosophy, it is downright stubbornness. For all that, it is the attitude most of us assume when we are confronted with a debatable question. and, unreasoning creatures that we are, we are never at a loss to know who is stubborn,—our side always is the right side. Take the question of the Central Station versus the Private Power Plant, for instance; for many years proponents of the two systems have argued hot and furiously over the respective merits of their systems, each side contending that the other was wrong.

Now, it was James Harvey Robinson who said that, "whenever a thing is universally accepted as being true, then it is well to question its truth seriously." And so it is, in this argument, a few in the industry with perhaps more reasoning power and less emotion than the rest of mankind, have suggested that perhaps there is a middle course, in which the respective advantages of both the Central Station and the Industrial Plant can be combined to serve one good purpose. In engineering circles at least this view is gaining headway. For this reason the article by Guy Randall in this issue is of interest for in it he contends that the "pooling of power," as he calls it, is the ultimate development of the Utility System. Coming from an engineer of Mr. Randall's calibre, this challenge to the Utilities is particularly significant.

Christmas in Arizona, or What Happens When the Load Goes Off

Maybe you think it's funny for us to be telling a Christmas story in June, and in Arizona, of all places. Well, it isn't. Even if there is no Santa Claus in it and even if the title seems "all balled up" with "load" and Arizona, we still insist it is a good Christmas story.

The load? Well, you ask us, "what does happen when the load goes off?"

It all depends. Usually the chief comes hot-footing out of his office, wanting to know what the h--l is the matter and what blankety-blank idiot did this or that, but that's not what we mean. What we refer to is this: Suppose you have a plant with a certain capacity which has been operating at or near full load for a long time. Then something happens — Congress passes another bonus bill, 'er sumthin', and as a consequence the load drops way down, clear out of sight. The load curve hides behind the zero line, not merely for a day but continuously for weeks and months; under these conditions, what happens to the costs?

Now this is where our Christmas story comes in, for this is just what happened at the Diesel plant of the Christmas Copper Co. at Christmas, Arizona, which, by the way, was described originally in our Feb. 1, 1931, issue. For the first year, this plant operated at a fairly high load factor, but the next year the famous Christmas depression came on the scene and the load fell off. What happened after that, how the unit costs were affected, which factors were important and which were not, forms an interesting story. Whether you run a Diesel plant or not, at least glance over the article on page 452 for some general principles of engineering are involved.

When the Load Goes Up

This is quite a different story. When the load goes up, one essential requisite is that enough generating capacity be available to meet it. Now, this is not always a simple matter; one cannot just take a Sears Roebuck catalog and say, "send over a 75,000-kw. generator tomorrow, we're getting some more load next week, so rush it." Indeed no; installing a generator or a transmission line, or building a dam is something that requires careful planning. On large utility systems, to maintain service in the face of rapidly increasing loads means coördinated planning, sometimes years ahead. It means exact scheduling so that the work of the engineering, purchasing, construction and operating departments dovetail properly to supply the service.

To show exactly how this is accomplished in a large organization, in this issue we describe the procedure and routine followed by the Byllesby Engineering and Management Corporation. Maybe your organization is not as large as Byllesby's—maybe it is only a little 200-hp. plant, but never mind, the general principles are the same and the details of the system can be adapted to the needs of a small organization.

"Ladies, Beauty is a Blessing of God,

—and everyone ought to preserve it; in fine, they do as much offend that neglect it, as they do that paint their faces."

This advice offered in 1686 by Stephen Draper in an advertisement of cosmetics addressed to the women of his time, sounds quite as modern as an advertisement in Vogue today. But we are not concerned here with the use of cosmetics, that seems to be a billion dollar industry in itself. The fundamental truth that "they that neglect beauty, offend" contained in Stephen Draper's statement, applies, however, as well to power plants and engineering structures as it does to feminine makeup.

Cosmetics for power plants? Why of course, nature's cosmetics, green grass, flowers, trees, shrubbery. When the sun and winds chap and burn Mother Nature's skin and when floods cut gashes in her shoulders, what does she do but reach into her bag, cover the scars with grass, shrubs and flowers.

In a similar way, man is applying nature's secrets. In the development of his industries, man often defaces natural beauty and while in the past he has thus done much to offend, today he is giving nature's cosmetics a chance to cover up the ugliness produced by his works. Power plant executives have discovered the value of landscaping the property around their plants in enhancing the value of their properties and in improving public relations. Some of the beauty spots in the industries of the country are illustrated in an article in this issue on the art of landscaping as applied to the power plant field.

POWER PLANT ENGINEERING June 1 1932

Engineering and Construction Schedules

When a new project is planned it is just as important to know when it can and will be finished as it is to know what it will cost. This article describes the methods used by one organization doing work for operating companies from Pennsylvania to Oregon and from Minnesota to Oklahoma. Methods of correlating costs and estimates were covered by the same authors in the N. E. L. A. issue of 1928.

By H. W. FULLER
Vice president in charge of Engineering and Construction

And W. B. RITTENHOUSE
Production Engineer

Byllesby Engineering & Management Corp.
Chicago, Illinois

SCHEDULES are time budgets. They are as essential to efficiency in the use of time as financial budgets are in the employment of funds. Especially is this true when engineering, purchasing and supervision of construction for many widely scattered projects are centered in one organization such as the Byllesby Engineering & Management Corp.

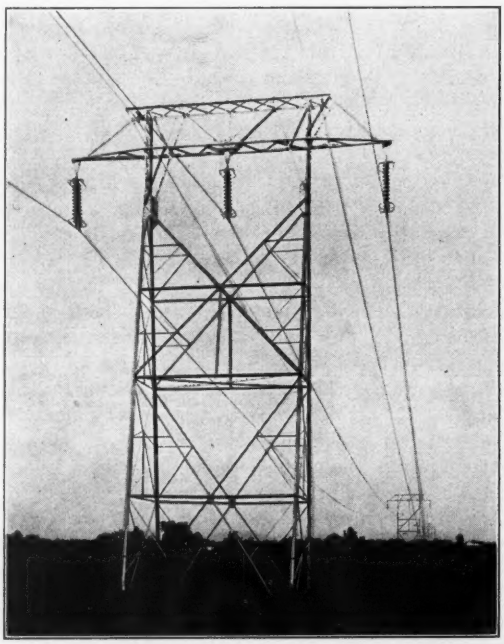
For several years this company has scheduled its operations with excellent results. Not only are projects, with few exceptions completed and ready for service by the dates specified, but the load factors of the various engineering and construction divisions are greatly improved, with consequent economy.

It has been contended that schedules prevent individual initiative and interfere with those sudden shifts of plan which the exigencies of all construction work occasionally demand. To guard against this criticism the scheduling system in use by this corporation has been made extremely flexible. Schedules are prepared only after obtaining a full expression of requirements and possibilities from all concerned; they are not arbitrarily made or enforced. The procedure must necessarily be centered somewhere and accordingly is assigned to the production division.

The system has been built around the central principle of publicity. As engineering and construction proceed, all information having a bearing upon the time element is made known to all concerned with the execution of the project. An unavoidable deviation from schedule by one division is promptly made known to other divisions thus enabling them to adjust their work if necessary. Intentional deviation from schedule by one division is permitted only if it does not interfere with the work of another division or with the schedule as a whole.

All changes in or developments of the schedule are, if practicable, made through the production division or, in an event, are immediately made known to that division. Informal agreements or private understandings between divisions are discouraged. All phases affecting schedules must be in the open and it is the business of the schedule section of the production division, as a clearing house, to keep them so. These and other features of the scheduling system are set forth in more detail in the following paragraphs.

The central purpose of the scheme is, of course, to bring all projects, under the supervision of the engineering department, to a satisfactory completion with a minimum of confusion, rush work, delays and expense. This can be brought about only by coordinating the work of the engineering and construction division of the engineering department, and that of the purchasing department as well as the promises of the manufacturer, with the desires and needs of the subsidiary and affiliated companies. To effect this coordination and accomplish these purposes, the various operations incidental to the execution of each project assigned to the engineering department are incorporated in a schedule in such detail as may be warranted by the nature and size of the project.



LOUISVILLE-COLUMBIA TRANSMISSION LINE
Authorized, Mar. 26 for Oct. 15; In service Oct. 14, 1930.

Duties of Production Division

Scheduling activities are centered in the schedule section of the production division but the division does not arbitrarily establish schedules. Its function is largely that of coordination as indicated by the following duties: Ascertains the views of assigned engineers, construction superintendents, purchasing department and operating officials with regard to requirements and possibilities in connection with all work assigned to the engineering department; assembles, adjusts and coordinates their ideas into tentative schedules; submits these tentative schedules for approval or modification; readjusts the schedules, if and when necessary, giving all possible consideration to the suggestions received and to reconciliation of incompatible requirements.

After readjustment, the section secures approval by the chiefs of all assigned engineering divisions, departmental heads and operating officials of the adjusted schedules and distributes approved schedules, which then become the official schedules and govern the time elements of all operations to which they apply. Subordinate schedules prepared by division chiefs or construction superintendents, made independently of the production division, must be compatible with official schedules.

Thereafter, by means of routine reports or special action it is necessary to: Keep informed of the status of all scheduled operations; disseminate information thereon; notify individuals of the proximity of "due dates"; and in critical cases, advise division chiefs, purchasing department, or the manager of engineering and construction of the necessity for prompt action to avoid serious lapses in the schedule. When circumstances necessitate, schedules are revised in the same manner employed in their preparation. Periodic and special reports are also prepared on matters relating to schedules, such as comparisons of scheduled operations and actual performances. It is the further duty of the production division to furnish information concerning the progress of work and conditions likely to affect it; all inquiries pertaining to this directed to the production division, although copies of urgent inquiries, at the option of the writer, may be sent to the manager of engineering and construction. This assignment of functions to the production division does not relieve division engineers, construction superintendents or the purchasing department of their duties to initiate within their appropriate spheres, such action as may be necessary to expedite any project, provided such action be taken through or made known to the production division. In fact it is not only the right but the duty of all who have part in a construction program to call attention to factors which might affect that program.

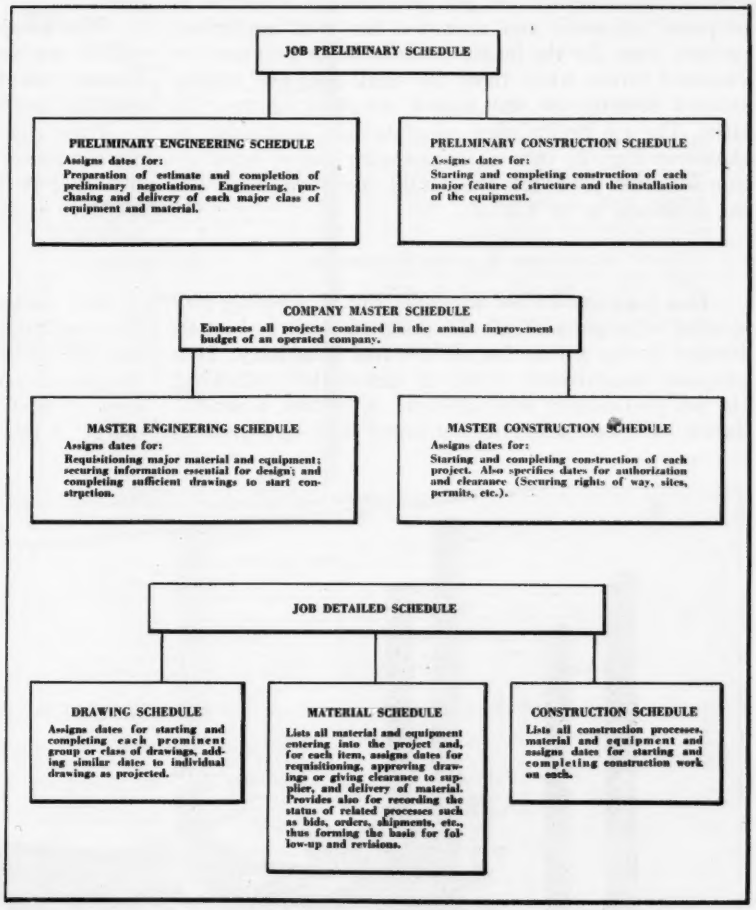

JOB PRELIMINARY SCHEDULE
PRELIMINARY ENGINEERING SCHEDULE
Assigns dates for:
Preparation of estimate and completion of preliminary negotiations. Engineering, purchasing and delivery of each major class of equipment and material.
PRELIMINARY CONSTRUCTION SCHEDULE
Assigns dates for:
Starting and completing construction of each major feature of structure and the installation of the equipment.
COMPANY MASTER SCHEDULE
Embraces all projects contained in the annual improvement budget of an operated company.
MASTER ENGINEERING SCHEDULE
Assigns dates for:
Requisitioning major material and equipment; securing information essential for design; and completing sufficient drawings to start construction.
MASTER CONSTRUCTION SCHEDULE
Assigns dates for:
Starting and completing construction of each project. Also specifies dates for authorization and clearance (Securing rights of way, sites, permits, etc.).
JOB DETAILED SCHEDULE
DRAWING SCHEDULE
Assigns dates for starting and completing each prominent group or class of drawings, adding similar dates to individual drawings as projected.
MATERIAL SCHEDULE
Lists all material and equipment entering into the project and, for each item, assigns dates for requisitioning, approving drawings or giving clearance to supplier, and delivery of material. Provides also for recording the status of related processes such as bids, orders, shipments, etc., thus forming the basis for follow-up and revisions.
CONSTRUCTION SCHEDULE
Lists all construction processes, material and equipment and assigns dates for starting and completing construction work on each.

FIG. 2. SCHEDULES OF THE THREE TYPES INDICATED AND DEFINED ABOVE ARE USED.

Procedure

Scheduling procedure must be sufficiently flexible to accomplish its purposes with a minimum of rigid rules. In lieu of such rules the procedure indicated in this article may be considered as typical, particularly for the larger projects. It is, however, subject to such modifications as may be practicable for the smaller or simpler jobs, or as may be required by the exigencies of individual cases. For work not requiring coordination between agencies the completion date only is scheduled, and local purchases are not scheduled unless their deliveries affect other schedules.

Regular dissemination of information concerning the status of every phase of a scheduled project is one of the most important features of the production division procedure and is designed to encourage and facilitate intelligent initiative on the part of construction superintendents, division chiefs and their responsible subordinates.

Job Preliminary Schedule

This preliminary job schedule, shown by Fig. 4 is designed to establish a completion date which, with due consideration to the periods required for engineering, delivery of material and construction and to the effect of this schedule upon the master schedule of

which it later becomes a part, most nearly satisfies service requirements. A job preliminary schedule is prepared, adjusted and approved for each authorized project, those for the larger projects being prepared on standard forms, while those for small jobs are usually entered directly on the master schedule referred to later. The job preliminary schedule may be divided, as shown in Fig. 1., into an engineering and a construction schedule, although frequently these two schedules are combined as in Fig. 4.

Company Master Schedule

This company master schedule, Fig. 5, schedule constitutes a program of all the assigned work to be performed during a year for an operated subsidiary. It is prepared concurrently with, or immediately following, the job preliminary schedules and is, in fact, a consolidation of those schedules, adjusted and approved as

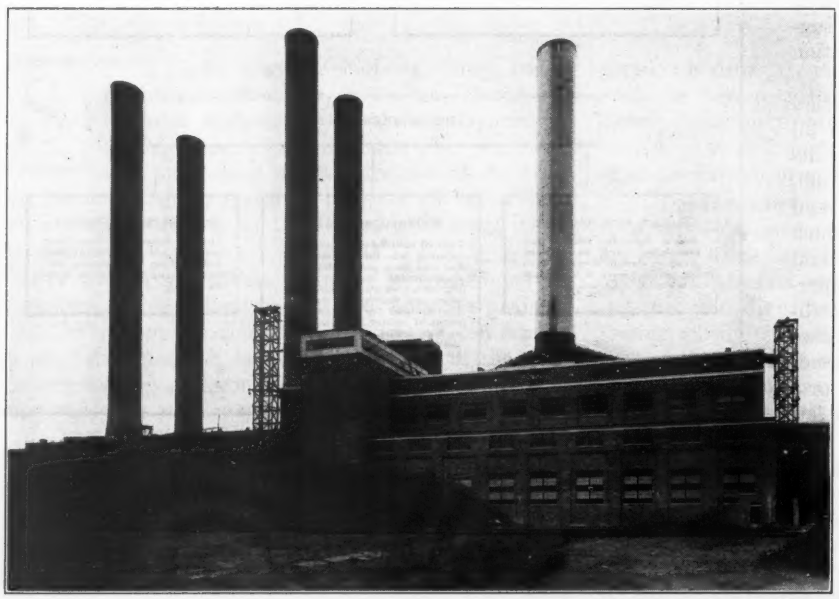


FIG. 3 ADDITION TO RIVERSIDE STATION, MINNEAPOLIS, MINN. NORTHERN STATES POWER CO. ONE 35,000 kv. TURBO-GENERATOR AND THREE 250,000 LB. PER HR. STOKER FIRED BOILERS, BUILDING EXTENSION AND STACK.

AUTHORIZED May 8, 1930. SCHEDULED FOR SERVICE AUG. 1, 1931.

PUT IN SERVICE AUG. 10, 1931.

explained earlier. This schedule is sectionalized, as shown by Fig. 2, into a master engineering schedule and a master construction schedule. A master schedule for the electrical engineering department is shown by Fig. 5.

Job Detailed Schedule

In due course, usually following the receipt of a detailed cost estimate, a job detailed schedule is prepared for each authorized project, except for certain very small jobs which may be adequately scheduled in the company master schedule. The job detailed schedule replaces the preliminary schedule and, after adjustment and approval by the production division becomes the official schedule for the project.

In the preparation of this schedule the construction superintendent is first consulted as to the most desirable sequence of the various field operations and their probable duration, but when drawing and material deliveries are known to be the controlling factors, these are brought to his attention in the form of a tentative schedule as a guide in formulating his construction program.

This schedule prepared in accordance with the accounts and sub-accounts of a detailed cost estimate, is divided into three sections: Drawing schedule; material schedule and construction schedule.

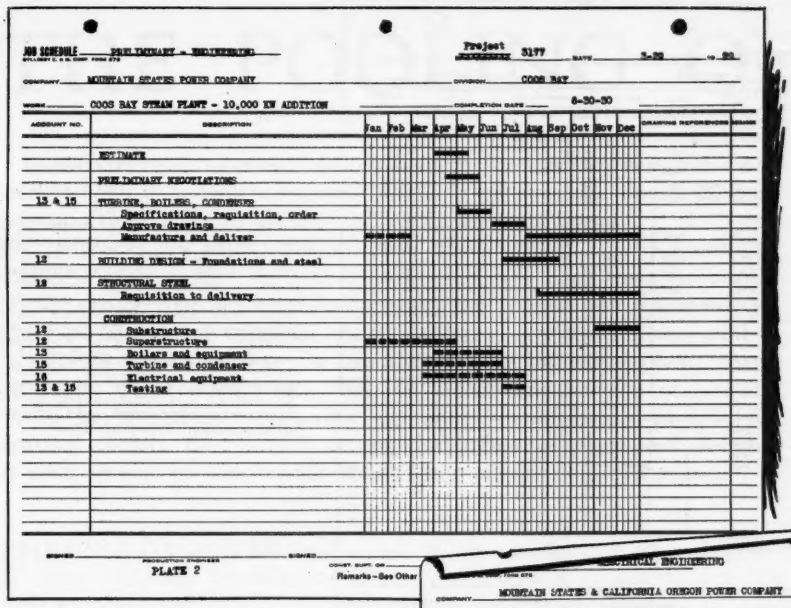
These subdivisions, defined in Fig. 2, naturally imply concurrent engineering work and obviate the necessity of a detailed engineering schedule. The drawing schedule is shown by Fig. 6 and the material schedule by Fig. 7.

Following Up Schedules

Any failure to observe a schedule which jeopardizes the completion date of a project, calls for an effort on the part of the production division to secure, through the proper agency, such special action as may be necessary to meet the scheduled completion date. The discharge of this duty requires the production division to be informed currently and accurately of the status of every element of each scheduled project relating to; engineering progress; drawing progress; status of materials and construction progress.

Engineering and drawing progress is noted by means of interviews, conferences, exchange of memoranda and records of work performed, reported on a special form made for the purpose. The drawings referred to must be identified by titles and drawing schedule numbers as well as file numbers.

Status of materials is verified in the following ways: Requisitions on the purchasing engineer drawn by division engineers, are routed through the production division to check their receipt against the schedule, to add a notation of the schedule dates for the return of approved drawings and delivery of the materials and to check the account classification. Proposals received by the purchasing department are transmitted to division engineers through the production division so that it may advise the engineers of schedule dates for their return. Proposals, with recommendations, returned by division



JOB SCHEDULE — PRELIMINARY — ENGINEERING — Project 3177 — DATE 3-30 to 30

COMPANY MOUNTAIN STATES POWER COMPANY — DIVISION COOS BAY

WORK COOS BAY STEAM PLANT - 10,000 KW ADDITION — COMPLETION DATE 6-30-30

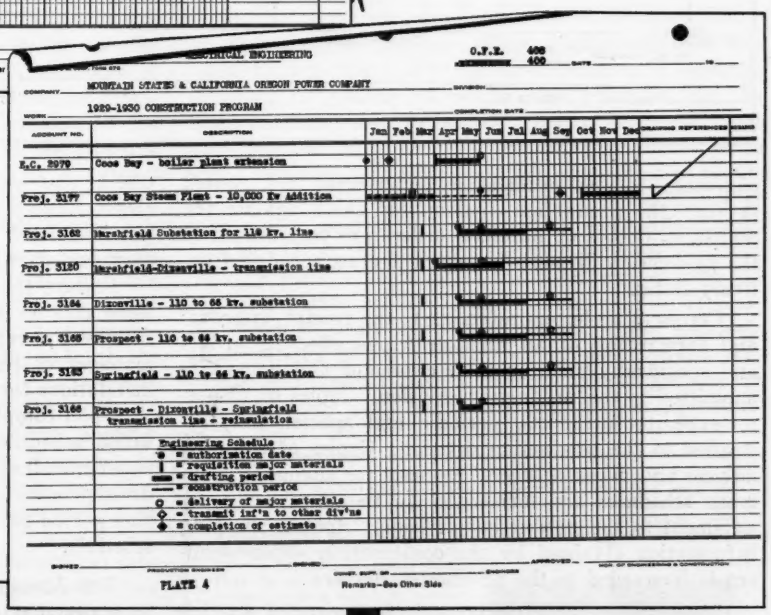
ACCOUNT NO.	DESCRIPTION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	DRAWING REFERENCES
	ESTIMATE													
	PRELIMINARY NEGOTIATIONS													
13 & 15	TURBINE, BOILERS, CONDENSER													
	Specifications, requisition, order													
	Approve drawings													
	Manufacture and deliver													
12	BUILDING DESIGN - Foundations and steel													
12	STRUCTURAL STEEL													
	Requisition to delivery													
	CONSTRUCTION													
12	Substructure													
12	Superstructure													
13	Boilers and equipment													
15	Turbine and condenser													
16	Electrical equipment													
13 & 15	Testing													

PLATE 2

Remarks—See Other

FIG. 4. JOB PRELIMINARY SCHEDULE

Construction schedule is filled out as soon as possible after it becomes known to the engineering department that a project is being considered, usually as the result of a preliminary conference. It is distributed to the engineering and construction superintendents to form a basis for discussions leading to the establishment of controlling dates upon which detailed schedules can be based. This is the form distributed to the engineers, the construction schedule is similar and the two are sometimes combined.



ELECTRICAL ENGINEERING — O.J.E. 400 400

COMPANY MOUNTAIN STATES & CALIFORNIA OREGON POWER COMPANY — DIVISION

WORK 1929-1930 CONSTRUCTION PROGRAM — COMPLETION DATE

ACCOUNT NO.	DESCRIPTION	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	DRAWING REFERENCES
W.C. 2979	Coos Bay - boiler plant extension													
Proj. 3177	Coos Bay Steam Plant - 10,000 Kw Addition													
Proj. 3162	Marshfield Substation for 110 kv. line													
Proj. 3180	Marshfield-Dixonville - transmission line													
Proj. 3164	Dixonville - 110 to 66 kv. substation													
Proj. 3165	Prospect - 110 to 66 kv. substation													
Proj. 3163	Springfield - 110 to 66 kv. substation													
Proj. 3166	Prospect - Dixonville - Springfield transmission line - reinsulation													

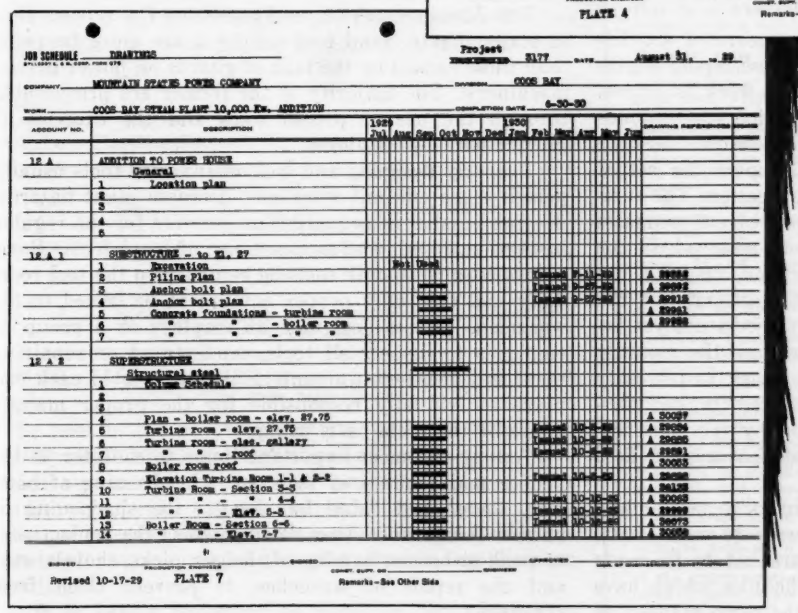
Engineering Schedule
- ▼ = authorization date
- | = requisition major materials
- ▬ = drafting period
- ▬ = construction period
- ○ = delivery of major materials
- ◇ = transmit inf'n to other div'ns
- ◆ = completion of estimate

PLATE 4

Remarks—See Other Side

FIG. 5. COMPANY MASTER SCHEDULE

The master construction schedule comprises construction schedules for all projects assigned to the engineering department which are included in the year's program for an operating subsidiary. It is prepared progressively as the individual job preliminary schedules are agreed upon and is approved and made official as soon as possible after the yearly budget is approved. It is distributed to all division engineers, construction superintendents and operating officials. The corresponding engineering schedule then has the same projects and in addition shows the controlling dates for the engineering schedule. It is prepared concurrently with the construction schedule but is distributed only to the engineers concerned, a separate schedule being prepared for each engineering division interested in the year's program.



JOB SCHEDULE — DRAWINGS — Project 3177 — DATE August 31, 30

COMPANY MOUNTAIN STATES POWER COMPANY — DIVISION COOS BAY

WORK COOS BAY STEAM PLANT 10,000 Kw. ADDITION — COMPLETION DATE 6-30-30

ACCOUNT NO.	DESCRIPTION	1929 Jul	Aug	Sep	Oct	Nov	Dec	1930 Jan	Feb	Mar	Apr	May	Jun	DRAWING REFERENCES
12 A	ADDITION TO POWER HOUSE													
	General													
1	Location plan													
2														
3														
4														
5														
12 A 1	SUBSTRUCTURE - to El. 27													
1	Excavation	Bal	Dwgs											
2	Piling Plan													
3	Anchor bolt plan													
4	Anchor bolt plan													
5	Concrete foundations - turbine room													
6	" " " - boiler room													
7	" " " " "													
12 A 2	SUPERSTRUCTURE													
	Structural steel													
1	Column Schedule													
2														
3														
4	Plan - boiler room - elev. 27.75													
5	Turbine room - elev. 27.75													
6	Turbine room - elev. gallery													
7	" " - roof													
8	Boiler room roof													
9	Elevation Turbine Room 1-1 & 2-2													
10	Turbine Room - Section 3-3													
11	" " " 4-4													
12	" " " Elev. 5-5													
13	Boiler Room - Section 6-6													
14	" " " Elev. 7-7													

Revised 10-17-29 PLATE 7

Remarks—See Other Side

FIG. 6. JOB DETAILED SCHEDULE

Construction schedule shows the periods required for each item of work included in the project. In appearance it is like Fig. 4 and is distributed to the engineers, construction superintendent and operating officials. The drawing schedule shown is coordinated with the others in order to provide drawings when required for purposes of construction or ordering. As prepared initially it shows schedules only for each group of drawings and is periodically brought up to date to show titles, file numbers, schedules, dates of issuing or individual drawings.

MATERIAL SCHEDULE — MOUNTAIN STATES POWER COMPANY — PROJECT 5177

WORK COOS BAY STEAM PLANT 10,000 KW. ADDITION — LOCATION COOS BAY — COMPLETION DATE 6-30-30

ACCOUNT	MATERIAL	REQUISITION DATE REQUIRED	REQUISITION ACTUAL DATE	CLEARANCE TO VENDOR DATE REQUIRED	CLEARANCE TO VENDOR ACTUAL DATE	MATERIAL ON JOB DATE REQUIRED	MATERIAL ON JOB ACTUAL DATE	REQUISITION NUMBER	BIDS REC'D	BIDS RET'D	PURCHASE ORDER NUMBER	PURCHASE ORDER DATE	PURCHASE ORDER DELIVERY DATE	SHIPPING ADVICE ADVICE DATE	SHIPPING ADVICE SHIP'T PROMISE	VENDOR AND REMARKS
12 A	ADDITION TO POWER HOUSE															
12 A 1	SUBSTRUCTURE							6496			216	6-26				Local
12 A 15	Wood piling		6-21													
12 A 16	Reinf. steel	9-15	9-24			11-15	Local	7163			216					Local 1.
12 A 16	Concrete materials	9-15	9-17			11-15	Local	7112			216					Local 1.
12 A 2	SUPERSTRUCTURE															
12 A 21	Structural steel	10-7	9-20	11-1*		1-15		7142			9-2810-S					
12 A 21	All anchor bolts for F&		9-26				Local	7112-1								Local
	Turbine Room steel	10-7	9-20	10-15		12-15		7142			9-2810-S					
	Boiler Room steel	10-7	9-20	10-15		1-1		7142			9-2810-S					
12 A 21	Revision	10-16				1-1		7142-1								
12 A 23	Hollow tile															
12 A 23	Brick															
12 A 24	Reinf. mesh	11-1		12-1		1-15										
12 A 24	Floor hardener	11-15		12-15		2-1										
12 A 25	Reinf. mesh	11-1		12-1		1-15										
12 A 25	Insulation	11-15		12-15		2-15										
12 A 25	Roofing & flashing	11-15		12-15		2-15										
12 A 25	Roof sumps	11-15		12-15		1-15			12-23	12-27						

REMARKS: For all accounts

*Bylesby Dwgs.

REVISION DATES: 10-17-29 PLATE 6 SHEET NO.

FIG. 7. JOB DETAILED SCHEDULE

This schedule is prepared concurrently with the construction schedule and lists all of the principal items of material necessary for the project. It is coordinated with the drawing and construction schedules and shows dates when each of the principal steps incident to ordering of the various items must be performed in order to have materials delivered as required by the construction schedule. It is distributed to the engineers concerned and to the construction superintendent.

engineers to the purchasing department are routed through the production division for check against the schedule. Copies of purchase orders are transmitted to the production division for check against scheduled delivery dates.

Copies of all letters referring to the receipt, approval and forwarding of all final drawings affecting orders and specifically defining their character and scope, are submitted to the production division. Copies of inspector-expeditor's reports, periodic and special, are forwarded to the production division. Copies of shipping advices and manufacturers' requests for change in shipment schedules are forwarded by the purchasing department to the production division. Special shipping information obtained by the construction superintendent is forwarded to the production division.

Construction progress is noted by means of six different reports. The monthly field progress report is prepared for each project on which field work is active. Each such report contains the construction superintendent's estimated date of completing field work; the date of starting field work and the final report the actual date of completion in readiness for operation. The summary of monthly field progress reports covers estimates of the progress made on all projects assigned to the construction superintendent. Report on projects not started contains the superintendent's estimate of the probable dates of starting work on projects not yet begun. The remaining two reports used are the monthly quantity report and completion forecast and weekly status of construction letters submitted to he manager of engineering and construction by the construction superintendent to cover salient features of field work.

It may be advisable to make changes in master and detailed schedules because of failures to meet basic scheduled dates but such changes are not to be made without thorough consideration. Schedules which have been made official are regarded in the same manner as official cost estimates and changes necessitated by circumstances within the control of the engineering department will be made only on the authority of the manager of engineering and construction.

Failure to meet schedules must be explained in the same manner as failures to meet cost estimates. Such failures are reported by the production engineer to the manager of engineering and construction with recommendations for such action as may be deemed necessary.

Upon completion of those projects for which job detailed schedules have been prepared, the construction superintendent is required to submit to the production division a record schedule showing the actual construction period for each significant item listed in the official schedule.

THE METROPOLITAN LIFE INSURANCE CO. reports that in many plants, hand tool accidents are more frequent than those caused by the lack of guards on power driven machinery. The majority of the former are preventable through the use of proper tools and the exercise of greater care by employes.

Properly designed and well maintained tools usually permit more efficient work and decrease plant hazards. A large number of organizations provide for the regular inspection, repair and maintenance of hand tools. Some plants require that all tools be returned to the tool room daily and that only proper equipment be issued to the workmen. Others designate an employe or a group of employes to inspect all tools, condemning or repairing them as conditions warrant. Still others hold each employe individually responsible for the proper maintenance of the tools he is using.

Among the most important items to consider in the proper maintenance of tools are: the dressing of hammer, sledge and chisel bar heads; the sharpening of knives, chisels and other cutting tools; the replacement of weak or broken handles of sledges, picks, shovels, etc.; and the repair of wrenches, to prevent them from slipping.

THE POOLING OF POWER

Interconnection of every electric load in the country regardless of ownership. . . . power company is willing to purchase dump power only at a price close to utility fuel cost in kilowatt hours. . . . if 10 or 100 deliveries are made, this so-called dump power rapidly becomes firm. . . . the sooner the public utility regards itself as a common carrier rather than a sole manufacturer, the sooner will the country enjoy an abundance of really cheap power. . . . if the highest established steam pressure were in use today in all industrial plants that use steam or produce waste heat, an astonishing surplus of power would be available. . . . power company would better fit into a national picture if it would accept the industrial plant and design its own service to supplement that of a modern industrial plant.

A Challenge to the Utilities

By Guy B. Randall

POOLING OF POWER was coined by the writer some years ago to designate what, in principle at least, seems a fairly natural, desirable and logical development. Briefly, in the limit it comprehends the interconnection of every electric load in the country regardless of the nature of ownership. As a natural consequence of this, all electric power stations of all kinds would be interconnected. The resulting vast network of electric conductors with ramifications extending hither and yon throughout the country would constitute the physical aspect of the pool. The practical result of this interconnection would be still more pool-like because one could pour in electricity at one side of the pool while removing an equal quantity at the opposite side without having the input traverse the pool. If electricity were poured in haphazardly from literally thousands of places and withdrawn at hundreds of thousands of places, diversity would have its maximum opportunity to balance peaks against valleys and bring about a maximum of leveling.

For control purposes, the pool would be divided into districts or blocks. The great number of power stations supplying the pool might be classified in some such fashion as this:

Relative Order of Numbers	Station Classification	Station Function
10	Primary	Meet all load demands not otherwise cared for to the limit of its capacity.
100	Support	Not in primary service but in a high degree of readiness.
1000	Reserve	Available in emergencies when Primary and Support cannot handle the situation.
?	Storage	These are hydroelectric stations capable of absorbing load by pumping to storage.
10,000	Free	All stations which may deliver or not as they may choose.

The pool might be owned by the nation-at-large, like our system of concrete highways (toll roads which were tried out a century ago did not work so well), by various companies like our railroads, or by one company like our telephone system. Regardless of ownership, the essential requirement of the pool idea is flexibility or fluidity.

It is hardly necessary to dwell on the advantages of such an arrangement. With a comparatively free market for power and great diversification of demands in mind, it possibly offers the most practical and the least visionary way to achieve greatly increased usage and decreased price provided only it is not loaded down with unreasonable costs and disproportionate profits during the building process. Granted the existence of such a pool, electricity would tend to be a commodity in fact as well as in name. As the pool network would be nothing more than a great transportation system for the most highly refined form of energy known to man, there would probably be less necessity for elaborate classifications of rates. They would tend toward simplicity and possibly have market quotation space in the columns of our daily papers like coal, iron, and potatoes.

GUY B. RANDALL has been intimately connected with the design, construction and operation of power plants for over a quarter of a century and is well qualified to speak with authority on the important subject of power interchange. Although his experience is primarily in the industrial field, that is, as a prospective user rather than a seller of power from utility systems, he is familiar with both sides of the question. His extensive experience has included more than four years design and construction experience on transmission and distribution lines and substations, valuable experience with the needs and facilities of many industries.

He is a graduate of the University of Missouri. During the war he spent two years as engineer-officer covering field operations of the Thirty-seventh Engineers, staff experience with chief engineer of the First Army, with the technical staff of the American Peace Commission and with Base Section No. 9 Antwerp.

The last twelve years have been in the design, construction and operation in the field of industrial power production and power application. He is well known for the work carried on in the development of pulverized coal as superintendent of power of the National Cash Register Co., Dayton, O., and more recently as superintendent of power of the Champion Coated Paper Co. of Hamilton, O. This latter company recently built under his design and supervision one of the outstanding industrial power plants in the country described in the December 1, 1930, issue of POWER PLANT ENGINEERING.

With a 27,192 sq. ft., 900 lb. boiler and a 20,000 kw., three cylinder turbine, a flexible design and adequate standby he is not willing to admit that power which might be supplied to the utility system is dump power worth only the fuel increment of cost to the utility system.

A state of more or less free competition could exist among the stations supplying the power, but this would not necessarily be an advantage for the large stations. In fact, domestic establishments might find it advantageous to have five or ten-kilowatt prime movers and under some conditions deliver power to the pool. Since energy can be transported more cheaply by pipe line, barge line, and railroad line, generally in the order named, than by electric transmission (if the distance is considerable) these three agencies would continue to grow and function as auxiliaries. Steam railroads might find it more advantageous completely to electrify their systems. Internal combustion engines would have a place.

Large Numbers Give Diversification

So-called free stations and to a large extent the reserve stations would, of course, be in the position where they could deliver or not according to the presence or absence of a natural surplus and a profit motive. The power from such stations might seem very uncertain and irregular. It might be if one considered only one station, but in the aggregate when hundreds and thousands of stations are considered the same law would function here that works so well in the thermodynamics on the one hand or in life insurance on the other. In the first case the law is hidden behind the somewhat formidable mathematical theory of thermodynamic probability. But most of the people who depend on the law never even heard of the mathematical basis. In life insurance the law functions under the descriptive term of actuarial statistics but the beneficiary gets the insurance just the same.

While, mathematically speaking, the solution of statistical problems appears rather complex, dealing as it does with such vague things as "most probable distributions" and "most frequent complexions," the final results are no more complicated than an interest table which most anyone with an elementary knowledge of arithmetic can use. So while the Free Stations might deliver so-called dump power exclusively, the resolving power of multitudinous irregularities would make firm a large percentage of the total. The bulk of the power for the country would come from these free stations and hydroelectric plants. The less sharp portions of the peaks would be carried by the primary stations and the sharp portions by primary stations and quickly functioning hydroelectric plants with water storage to draw on. The simple hydroelectric plants would be particularly useful in meeting quick sharp peaks while hydroelectric plants which could pump water for storage would be valuable to absorb load in case of temporary surplus of input over output as well as for ordinary peak service.

First reactions to these preceding paragraphs may possibly be summarized by such adjectives as utopian, idealistic, visionary, or just far-fetched. Forty years ago, anyone with the temerity to predict the situation as it exists today would probably not have gotten off thus lightly, but this is not a plea for kind words for the picture. Let the facts speak for themselves. Power development up to, say, eight or ten years ago made those who were especially receptive to the idea of great power stations advertise their beliefs nation-wide under the attractive appellation of super power. Briefly the picture left in the lay mind was that of super-gigantic turbines in super-cathedrals of power. Yet the pessimist of that day—one, say, familiar with the avidity with which scientists were (and still are) tearing apart the atom to see how and why matter possesses so much stored but not now available energy—might well have painted in contrast a picture in which all the power was supplied by multitudes of little gadgets, one in the basement of every home and factory, functioning on the fascinating idea that a tea cup of hydrogen condensed to helium contains ample power to drive the greatest liner across the Atlantic—if it could be harnessed. The probable truth is that the real development of the next forty years will lie between these two extremes and along the line suggested in the first paragraphs, really a median solution. But how is one to reconcile any such development with the present policies of the great majority of the public utility power companies? The answer is, it is difficult. It is difficult for the following reasons:

High Pressures and Temperatures Change Trend

Rapid growth of the utility power companies to their present position has been due in a large measure to their active campaign to put the so-called isolated or industrial plant out of business. As a business policy this worked beautifully up to about the year 1920 or 1925. As a rule the saving to the industrial company was not great but at equal expense the industrial manager felt he was getting rid of a troublesome department, that of generating electric power, and he could reduce his capital investment a little or use the funds in other departments of his business. Then the reverse action set in. Due to awakening interest in a century old principle of thermodynamics, purely a principle of harnessing molecular energy based on statistical effect, improved machine shop and metallurgical practice, it was suddenly found out that great advantages were obtainable from high fluid pressures and temperatures.

Leaders in this were the industrial plants in Europe and the oil refineries in the United States. As this development began to spread to the utility power companies in this country, the more progressive engineers quickly saw that though high pressures and temperatures were profitable for utility power plants they were far more profitable for industrial plants. They not only served to make the industrial power plant less dependent on a large cooling water supply but where considerable process steam is used they enabled surplus power generation on a by-product basis.* Where competent engineering guidance has been secured, many industrial executives have been by no means slow to see and profit by these possibilities. The rejuvenation of many old industrial power plants about to succumb to purchased power pressure and the building of many completely new high pressure industrial plants quickly followed. The results, except in one or at most two cases, have fulfilled or even surpassed expectations. The saving to be effected in these modern high pressure industrial plants is not a matter of speculation. It is a proven fact. But the savings could be still greater and at the same time the utility power company could better fit into the national picture if it would accept the industrial plant and design its service to supplement that of the modern industrial plant.

*For further description of this effect refer to article by the writer on page 4 of The Paper Mill & Wood Pulp News issues of March 19 and March 26, 1932.

To quote a previous statement** of this writer, "As matters now stand the public utility power company does not in general seem disposed to buy firm power from an industrial plant and is willing to purchase dump power only at a price close to the utility's fuel cost of a kilowatt-hour. It is easy to demonstrate that at this price there is little or no incentive to design to get the maximum of this, the world's cheapest power. It is also easy to demonstrate that by the standard of present utility rates dump power is worth far more than this. But an attractive price for dump power gives the utility a double handicap. It increases the incentive to build modern industrial power plants which in turn means loss of more revenue bearing load for the utility —a vicious circle. No utility company can wisely ignore the plain implication of this trend. Looking at the problem from the large standpoint of national economics and national welfare, it would appear that the sooner we develop a large power network with great freedom of pool action—that is, the sooner the public utility regards itself as something of a common carrier rather than sole manufacturer—the sooner will the country enjoy an abundance of really cheap power. Our national power problem is not solved until the cheapest power has a reasonably good road to market. Meanwhile it would appear advisable for industrial plants not to make long time dump power commitments for the market may improve considerably within the next ten years."

Firm Power from Dump Power

Utility power companies can hardly prevent the return of the industrial power plant to a position of greatly enhanced usefulness and usage. They can, however, retard somewhat the rate of this return through the continued use of their primary weapons, high charges for emergency or stand-by service and the monopoly of the usage of power highways except at a prohibitive price. It is true that all utility power companies will furnish stand-by service at a price. But that price is so high as to function primarily as an exclusion act. Utility companies do not really want to furnish this kind of service because it encourages the installation of individual power stations. They will also accept dump power only at the price equivalent of fuel dumped in their own bunkers. Both these policies are based essentially on dealing only with a single party this way and making money at that. Practically no provision is made for dealing with two or more because the success of the rate is apparently measured by the paucity of the results.

By the laws of probability, or diversity if one prefers the word, ten customers using stand-by service would not have anything like ten times the demand of one. So far as the central power station itself is concerned, a kilowatt of capacity set aside to serve one customer could about as effectively serve a hundred with this particular service. In much the same way if a single industrial plant delivers dump power to an electric distribution system the view can be taken that the energy is worth only the utility power companies' fuel cost of a kilowatt-hour (plus transmission line losses). If ten or a hundred deliveries are so made, this so-called dump power rapidly becomes firm for obvious reasons, and the scattered nature of this power adds an element of great value to any network or pool. To charge a low rate for stand-by service and pay an attractive rate for dump power so that a large volume of business (with corresponding firmness) would be secured presupposes loss of many of the present type of power customers at present established rates. A compensating factor may be found in an increase in the custom of sharing industrial plant loads with such industrial power plants.

In such a case, the electric transmission and distribution systems would continue to grow but the increased prime mover capacity would come rather from industrial power plants than from additional or enlarged central stations. There is another complicating factor. The feeling exists that power rates, because of industrial plant competition, are relatively much lower than domestic rates. Evidence of this seems to be found in the tendency for some municipalities to go back into the municipal lighting business, give domestic rates as low or lower than the utility power companies and pile up attractive surpluses for the benefit of the community. Because of the equalizing effect of the state public utility commissions, a utility company finds some difficulty in setting low rates in one community to eliminate competition while maintaining higher rates in others. So broadly speaking, there appears at least some basis for the growing belief that utility power rates may have to come down substantially all along the line from the smallest to the biggest user or serious loss of existing business will result. A dilemma of this kind may encourage some of our utility companies to try out seriously the pooling idea. An Eastern engineer in commenting on this idea brought out the fact that one of the most profitable power companies in New England never owned a power plant.

Who Will Make the Analysis?

Without doubt a most painstaking and comprehensive analysis must be made of the pooling idea before the full extent of its possibilities are manifest. Such a pool could not spring up, like mushrooms, overnight. Some sections of the country are immediately more favorable for it than others. Pooling would have to start in such sections and its growth be made possible by suitable provisions to prevent clever financial operators from blocking the road of progress until the price set on their blockade was met. Who shall make the investigation or analysis of the plausibility of such a scheme? The utility power companies? The large power purchasers? The domestic purchasers? Or the State? If such an idea proved perfectly feasible and sound, how would it overcome the pressure of things as they are? How should the resulting profits be shared? These are difficult questions to answer. The writer does not attempt to answer them because they are in part, at least, social problems of some complexity.

These points, however, do stand out. If the highest established steam pressures were in use today in all industrial plants which use steam or produce waste heat, an astonishing surplus of power would be available over that consumed by the immediate industrial loads. Wherever fuel is burned and the maximum practicable thermodynamic effect is not obtained, there is economic waste. But industrial plants, facing daily competition which challenges their existence, are not likely to spend money to produce blocks of highly refined surplus power,

**A.S.M.E. Fuel & Steam Transactions, September-December, 1931, page 346.

as stated, the cheapest in the world, which may be received or may be refused but even in the more favorable case will be paid for only at raw coal prices by a public utility group which so far appears reluctant to apply statistical methods to break down service and incoming power because it will make industrial power plants more popular. On any extended basis this is somewhat like going into business with a party whose primary interest it is to see one fail.

Yet there is a logical field for service for both isolated and central power production. These fields sometimes cover complementary portions of the same load. Dump power will continue to be made and a part of it will be sold for a time at a very nominal price. Yet the fact remains that the present competitive set-up of the utility group is designed to offer the maximum of discouragement to the potential as well as the actual industrial power producer. This appears something of a relic of an economy of the past. The net total result of this failure of economic coördination will almost surely be an unnecessarily high power cost for the country-at-large and an increase in the world's entropy, the scientific yardstick of its material degradation. The hopeful alternative seems to lie in the development of a practical plan for pooling power so there will be something like equitable distribution of the benefits accruing from the resulting economies in generation and in distribution.

Joint Plants Doomed to Failure

Utility power companies have enjoyed something like forty years of development on what is fundamentally a single set of ideas. As briefly sketched in the foregoing there are reasons for believing that future growth will depend more on coöperation than on competition in the accepted sense of the past. This probably means extensive revision of existing rates as relates to emergency service, complementary service, and dump power. Most of the serious objections to a pooling plan appear to be answered effectively by the creation of a power board with suitable authority for requiring pool members to meet the pool regulations and standards. Attempts of utility companies to acquire widespread joint or exclusive ownership of industrial power plants, this writer believes, are foredoomed to failure for obvious reasons. Ownership of prime movers is likely to be much wider in the future than in the past. But the ownership and organization of the transportation agencies for carrying raw energy to and surplus refined energy from these prime movers appears to be a rather different matter. These agencies in the limit may all become common carriers in fact.

Reduced Load Affects Diesel Operating Costs

Data for 1930 and 1931 From 4-Engine 1800 h.p. Plant of Christmas Copper Co. Provide Excellent Case Study of Relations of Load and Various Items of Cost

OPERATING COSTS for the Diesel engine generating plant supplying power to the 400-t. concentrator at the Christmas Copper Co., Christmas, Arizona, have been made available through the courtesy of the company and are presented in detail in the accompanying tables. The power plant itself was described in the Feb. 1, 1931 issue of Power Plant Engineering. For 1930 the average operating cost for the plant was $0.0084 or 8.4 mills per kw-hr. and for 1931 it was $0.0093 or 9.3 mills per kw-hr. the increase being caused by reduced load during the last 8 mo. of 1931.

This Diesel plant incorporates many refinements of equipment, although the plant building itself is extremely simple because of its geographical location. Four Chicago Pneumatic six-cylinder, four-cycle, solid-injection Diesels, 450 hp. rated capacity each, drive G. E. 300-kw., 2300-v., 0.8 P. F., 3-phase, 60 cycle generators with direct-connected exciters. Because the plant is 2150 ft. above sea level, the actual capacity of each engine is about 272 kw. Plant load factor (ratio of average load to peak load of plant) for 1930 was about 70 per cent but because of changed operating conditions in 1931 was probably much lower.

Fuel burned is California crude of about 24 deg. Baume gravity with a heating value averaging 140,000 B.t.u. per gal. Cooling water, pumped by air lifts from deep wells, is stored in a 4200-gal. storage tank under float control. It is cooled by passing through a 35-ft. cooling tower. Makeup cooling water, which amounts to about 8,000 gal. per 24 hr. under normal operation is treated in a zeolite water softener. Air for combustion in the engines is filtered, the exhaust manifold is water jacketed for cooling at the engine, exhaust piping is insulated and mufflers are provided. Each engine is equipped with Brown pyrometers. Forced-feed lubrication serves the engines throughout, the oil being purified with a centrifuge and batch reclaimer installation.

During 1930 the four engines operated under normal conditions, the fourth unit beginning operation in April of that year. As noted above, the plant load factor was about 70 per cent. Fuel oil cost $0.047 or 4.7 cents a gallon and lubricating oil $0.73 or 73 cents a gallon except in December when it cost 76.5 cents. Total fuel oil consumption for 1930 was 493,574 gal. and total lubricating oil consumption was 7,191 gal. Since the total output of the plant was 5,212,300 kw-hr. for 1930, the fuel oil consumption was 10.55 kw-hr. per gal. Lubricating oil consumption averaged about 740 kw-hr. per gal. Average operating cost of 1930 was 8.4 mills per kw-hr.

TABLE I. OPERATING COSTS, 1930, CHRISTMAS COPPER CO., DIESEL PLANT

1930 MONTH	FUEL OIL CONSUMPTION	LUB. OIL CONSUMPTION	ATTENDANCE & MAINT. LABOR	POWER REPORT SUPPLIES-MISC. EXPENSE	OUTPUT Kw-hr.	FUEL OIL CONSUMPTION Kw-hr. per Gal.	COST PER Kw-hr.
JANUARY	39090 GALLONS	5004 GALLONS	$ 930.00	$217.70	430,100	10.99	$0.0070
FEBRUARY	36140 "	4204 "	990.15	232.49	396,000	10.7	0.0084
MARCH	48814 "	628 "	1088.51	244.05	468,400	11.05	0.0088
APRIL	46300 "	650 "	993.90	456.84	488,800	10.7	0.0084
MAY	42980 "	708 "	1044.05	382.60	449,900	10.3	0.0089
JUNE	40930 "	649 "	960.00	841.57	425,700	10.4	0.0095
JULY	41040 "	6084 "	921.90	293.84	429,600	10.25	0.0085
AUGUST	43250 "	6454 "	927.13	497.97	451,100	10.7	0.0085
SEPTEMBER	43000 "	640 "	961.41	268.77	440,900	10.45	0.0087
OCTOBER	44100 "	427 "	884.62	186.79	456,000	10.38	0.0079
NOVEMBER	30960 "	474 "	960.00	316.02	411,320	10.55	0.0089
DECEMBER	43150 "	566 "	771.00	289.81	444,300	10.55	0.0085
TOTAL	493574 "	7191 "	10937.02	4418.47	5212,300	(Aw.) 10.55	(Aw.) 0.0084

Price of Fuel Oil - $0.047 per gal. Price of Lubricating Oil - $0.73 per gal. Except December - $0.765 per gal.
Total Fuel Oil Consumption - 493,574 gal.
Total Lubricating Oil Consumption - 7,191 gal. Total output - 5,212,300 kw-hr
Kilowatt hours per gallon fuel oil - 10.55
Average cost per kilowatt hour - $0.0084

Fixed charges such as taxes, interest, general company overhead, insurance on machinery and buildings and depreciation, are not given in the tables. The items included under attendance and maintenance labor require no explanation. Under the heading of supplies and miscellaneous expenses are included salt for the circulating water treating system, ink and charts for recording instruments, rags and waste, paint, cup grease, penetrating oil and any replacement parts that did not increase capital charges.

TABLE II. OPERATING COSTS, 1931, CHRISTMAS COPPER CO., DIESEL PLANT

CHRISTMAS COPPER COMPANY POWER REPORT FOR 1931

	POWER DATA		FUEL OIL		LUB. OIL		OPERATING COSTS					
MONTH	Engine hours	Kilowatt hr. output	Gallons consumed	Kilowatt hrs. per gallon	Gallons consumed	Engine hrs per gallon	Fuel oil	Lub. Oil	Labor	Supplies, Ins. & Misc. Expe.	Totals	Cost per Kilowatt Hour
Jan.	2,264	465,800	42,700	10.92	619	3.65	$1,921.50	$473.52	$822.26	$369.46	$3,586.74	$0.0077
Feb.	1,746	395,200	36,850	10.72	530	3.29	1,658.25	405.45	640.64	304.90	3,009.24	.0076
Mar.	1,971	439,100	40,990	10.70	543	3.66	1,844.55	415.40	826.16	347.57	3,333.68	.0076
April	1,959	386,200	35,760	10.78	338	5.81	1,610.10	258.57	812.27	224.01	2,904.95	.0075
May	1,064	127,000	14,210	8.95	126	8.45	574.08	96.39	701.93	111.29	1,483.69	.0116
June	1,262	146,000	16,710	8.75	206	6.13	675.10	157.60	639.30	252.90	1,724.90	.0118
July	746	46,300	7,377	6.27	78	9.57	298.03	59.67	464.68	201.44	1,023.82	.0221
Aug.	748	41,760	7,028	5.93	75	9.97	283.93	57.38	451.44	44.24	836.99	.0205
Sept.	720	39,350	6,691	5.89	160	4.50	270.32	122.40	427.20	68.74	888.66	.0225
Oct.	496	35,250	5,043	6.89	56	8.86	203.73	42.84	313.72	51.32	611.61	.0173
Nov.	480	42,475	5,381	7.90	50	9.60	217.39	36.00	303.60	52.55	609.54	.0143
Dec.	371	40,275	4,750	8.48	40	9.34	191.90	28.80	215.72	53.62	490.04	.0122
TOTALS	13,827	2,204,650	223,510	(Ave.) 9.88	2,821	(Ave.)4.91	$9,748.88	$2,154.02	$6,818.92	$2,082.04	$20,503.80	$0.00930 (Ave)

Examination of the 1930 table shows that the average output was fairly uniform, the lowest monthly output being in February, 386,000 kw-hr. and the highest in March, 466,400 kw-hr., most of the values, however, lying between 411,000 and 440,000. The small variations in monthly costs per kilowatt-hour do not seem to bear any definite relation to the comparatively small variation in monthly outputs and the fuel consumption in kilowatt-hours per gallon is also fairly uniform, most of the values ranging from 10.3 to 10.7 kw-hr. per gal.

When we turn to the 1931 costs we find some extremely interesting items. For the first four months of 1931, mining operations of the Christmas Copper Co. were conducted at a normal rate. During the remainder of the year, however, the concentrating plant was closed and all other activities reduced to a minimum.

As will be noted, the kilowatt-hour outputs for January, February, March and April, 1931 were comparable with those of 1930 resulting in fuel consumption ranging between 10.70 to 10.92 kw-hr. per gal. for the four months which were in practically the same range as those for 1930. The lubricating oil consumed was a trifle less, attendance and maintenance charges a little lower, also charges for supplies and miscellaneous expense, including the same factors as for 1930. Fuel and lubricating oil prices decreased slightly. The final results were operating costs per kilowatt-hour as follows: January, 7.7 mills, February, 7.6 mills, March, 7.6 mills, April, 7.5 mills. These are appreciably lower than the general trend of unit operating costs for 1930.

When the load dropped in May, 1931, to only 127,000 kw-hr. and continued to decrease to 35,000 or 40,000 kw-hr. in the last three months of the year, the effect of this on the other cost items is striking. Fuel oil economy decreased somewhat to values ranging between about 6 and 9 kw-hr. a gallon. Engine hours per gallon of lubricating oil increased as might have been expected. Labor costs gradually decreased.

The final result was an increase in operating cost from 7.5 mills per kw-hr. in April to 1.16 cents per kw-hr. in May and with the cutting of the load from 146,000 kw-hr. in June to only 46,300 kw-hr. in July, a decrease of about 70 per cent, the unit cost went up to 2.21 cents per kw-hr. After May, 1931, three monthly unit costs of over 2 cents per kw-hr. are noted. It is also apparent, however, that the decrease in lubricating oil consumption, supplies and miscellaneous expense and labor during the last three months of the year had an appreciable effect in getting the costs for October, November and December down to 1.73 cents, 1.43 cents and 1.22 cents per kw-hr. respectively.

To sum up then, here is a most interesting set of operating cost figures on a modern, well-equipped Diesel engine plant showing in detail what happens to its operating costs when the normal load is quickly reduced and the plant does not shut down entirely but continues to operate at light load. Consideration of such costs must include, of course, the total costs as well as the unit costs. The cost per kilowatt hour, let us say, has just about doubled between March and September; on the other hand, the total operating cost has decreased from $3,333.68 to $888.66 in September or to about one-fourth of the former cost. Taking it for the entire year 1931, the total operating cost has decreased to 1/7 or about 14 per cent of that for January, whereas the cost per kilowatt hour has increased only about 60 per cent. It would appear that the changes in all these costs were brought about almost solely by the great decrease in load. A general engineering principle, of course, is that economy of any machine increases with load factor and here in these records is found further evidence of just which operating factors in a Diesel plant are most affected by a lowering of load factor. Inasmuch as this plant of the Christmas Copper Co. is a fairly new plant, incorporating the requirements necessary for efficient and economical operation, the data should prove of interest and value to Diesel owners and operators everywhere. We are indebted to the Christmas Copper Co. through its treasurer, Roland H. Knight for the opportunity to publish them, also to H. A. Rossell, manager of the Christmas plant and C. A. Bilson, power plant superintendent.

POWER PLANT ENGINEERING June 1 1932

LANDSCAPING — A Power Plant Problem

By
OAKLEY V. MORGAN* and
JAMES H. BURDETTE**

Trees and Shrubs, Green Grass and Flowers When Artistically Used Contribute a Wholesome and Satisfying Environment to Industrial Premises

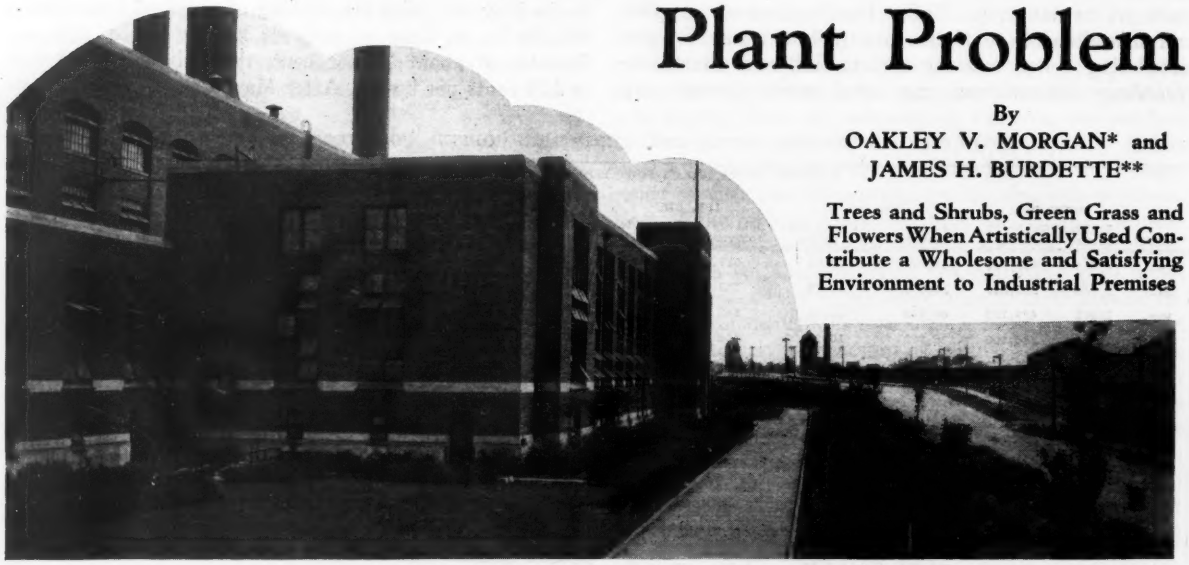


FIG. 1. AN EXTENSIVE LAWN, SURROUNDED BY CAREFULLY SELECTED BUSHES AND SHRUBS ALONG WALKS, FOUNDATION AND FENCE, IS AN ATTRACTIVE FEATURE OF CALUMET STATION IN CHICAGO

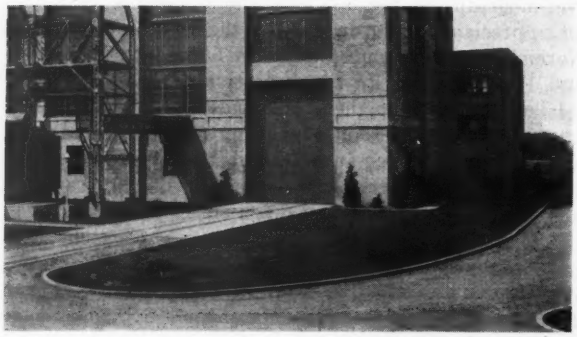


FIG. 2. A FEW SHRUBS AND A PATCH OF LAWN BEAUTIFIES THIS CORNER OF SHUFFLETON POWER PLANT, RENTON, WASH.

ONE OF THE charges brought against the machine age is that it destroys beauty. The charge is deserved, but need not continue to be. Engineering design is concerned first with efficiency. Efficiency is not embraced wholly in the problem of obtaining the maximum power from a given amount of fuel.

In the pioneer stage of industrial development, attention has been concentrated upon the efficiency of production, because that problem taxed the ability of the planners. The time has come when efficiency in other directions may be sought; and it is now possible to direct attention to the esthetic and social values of industrial plants.

An institution which creates an environment of ugliness and disorder, is inefficient, however low its production cost. It fails its community in points which are quite as important as the production of goods. Goods

*Horticulturist, Commonwealth Edison Co.
**Vaughan's Seed Store.

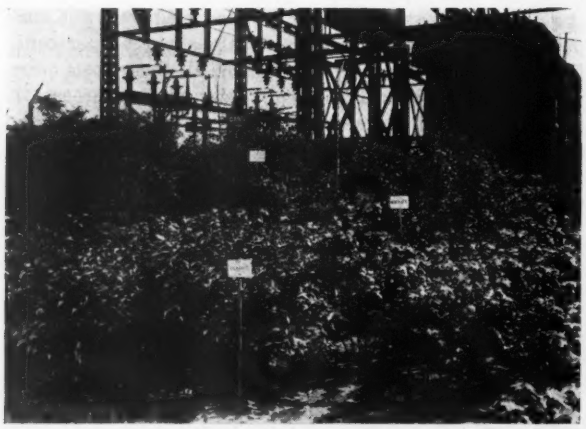


FIG. 3. ATTRACTIVE SHRUBS SHIELD TRANSFORMER STATION AT CALUMET STATION

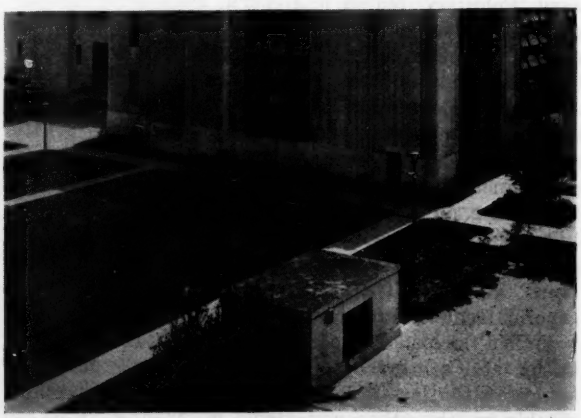


FIG. 4. AT LONG BEACH NO. 3 A SCREEN OF SHRUBBERY AROUND THE VAULT MAINTAINS THE HARMONIOUS BEAUTY OF THE LANDSCAPING AND ARCHITECTURE

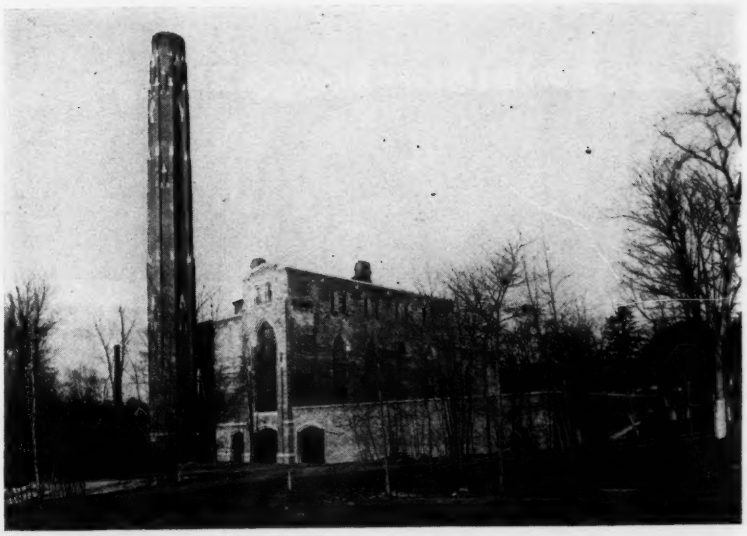


FIG. 5. IN SURROUNDINGS AS NATURALLY BEAUTIFUL AS THOSE ABOUT THE POWER PLANT OF ST. PAUL'S SCHOOL IN CONCORD, N. H., HARMONIOUS ARCHITECTURE IS THE ALL IMPORTANT PROBLEM WHICH HAS BEEN WELL SOLVED HERE BY FRENCH & HUBBARD

are produced for the use and enjoyment of men, in order that their lives may be more wholesome and satisfying. The plant in which they are made should contribute to the same end and thus not only be planned for the health and comfort of those who work within but it should be an object of beauty in which its neighbors may take pride.

Architects of industrial buildings have begun to recognize this need; and now it is time for the surroundings of such buildings to be put in order. To do this is the task of the landscape architect. The world is of Nature's shaping; and everything in the world which is beautiful must harmonize with the work of Nature. Buildings which are set in the midst of grounds resembling open wounds on the face of the earth, where Nature's clothing has been violently rent, and the naked surface beneath left gaping and unhealed, cannot be beautiful whatever the pains the architect may have taken in their design.

To make them look right, natural beauty must be restored in their environment, and the restoration must be planned with skill, so that harmony is created between the architectural form and the beauties of nature. This is the technical problem which landscape architects face when planting near buildings. They must make the structure which men have reared look at home in a world which nature made.

If a building is well designed, the landscaping should enhance its beauty, set off its fine points, soften its harsh lines and provide a setting for its beauty. If the structure is carelessly designed, the landscape planting may conceal its defects and to some extent redeem its faults. The landscape architect is an artist whose job is not to paint, but to create a picture. He works with trees, shrubs, flowers and grass, to evolve a scene into which the building blends as part of a harmonious whole. We will endeavor to suggest, in a brief way, how he goes about it and what particular materials he may use.

The secret of good design in industrial grounds is like that of good design in the buildings themselves. It depends on adaptation to function and good taste. The efficiency of plant management must be maintained and accesses to all entrances to buildings and working parts on the grounds established. Walks, drives, railroad tracks, working areas and storage grounds should be laid out in accordance with the greatest efficiency for plant management and harmonize with the natural beauty of the surroundings.

Long sweeping curves in the walks and drives are safer and far more beautiful than straight lines and sharp turns. Working areas and storage yards should be placed, if possible, to the rear of the property and be screened by trees, shrubs, vines, or in congested areas by Du Bois or similar native wood fence. Walks, drives and fences of good design and of proper construction of substantial material express safety and stability.

Trees and shrubs are not only used to soften, enhance or add a touch of decoration to the beauty of the architecture of the buildings and to screen from view unsightly objects. They absorb noises, help clarify the air and regulate atmospheric temperature. Dense foliage of trees and shrubs sound proof the purr and rumble racket of the power industry. Massive evergreens of

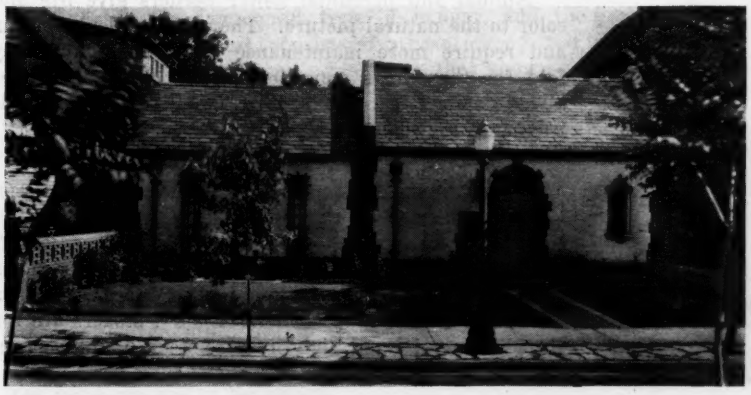


FIG. 6. THE PLACING OF SUBSTATIONS IN THEIR MOST EFFICIENT LOCATION HAS MET WITH DISAPPROVAL IN MANY LOCALITIES, BUT WHAT RESIDENTIAL NEIGHBORHOOD COULD OBJECT TO A BEAUTY SPOT LIKE THE WINDSOR PARK SUBSTATION IN CHICAGO?

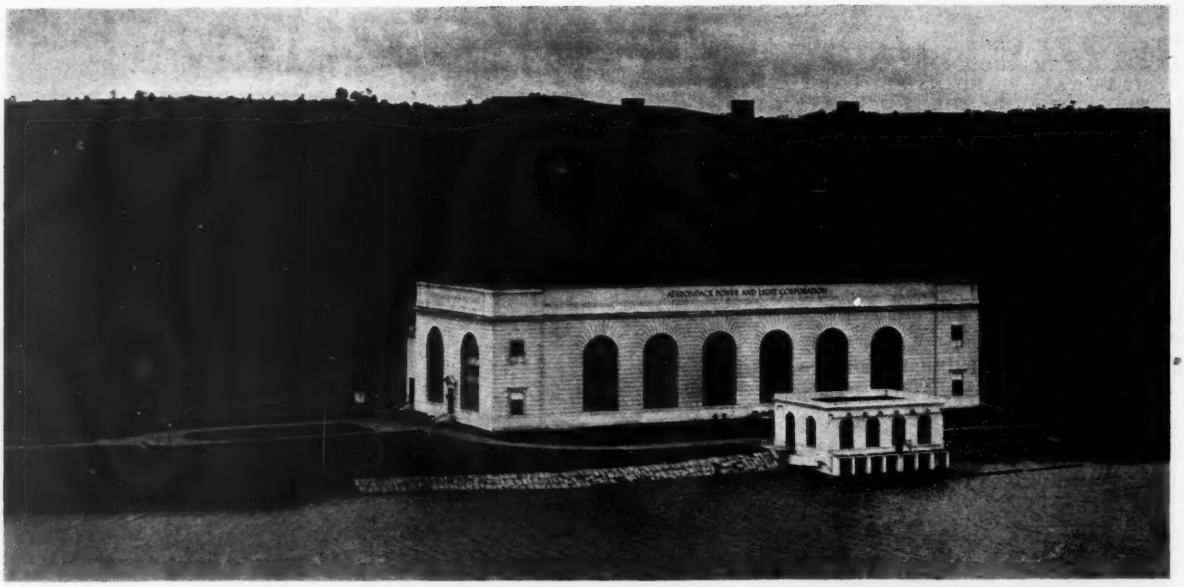


FIG. 7. THIS EXPANSE OF CLEAN LAWN AROUND THE AMSTERDAM PLANT OF THE ADIRONDACK POWER & LIGHT CORP. ON THE MOHAWK RIVER IS A DELIGHT TO THE EYES, DAY AND NIGHT, WINTER AND SUMMER

pine, spruce or cedar are most efficient in noise absorption but they will not thrive in a smoky atmosphere.

Tons of dust and ashes are collected on the green foliage to be washed to the ground by the next rain and thus free the atmosphere of its burden. Carbon dioxide emitted in enormous quantities in industrial centers is a food for the growing plant. This formation of organic material from carbon dioxide by the green plant is the process which renders possible the life of all other organisms and in particular of animals upon the earth.

Not all plant life will thrive under the severe adverse conditions of industrial neighborhoods. Planting material must be selected which not only conforms to the height, shape and form for which it is to be used but it must be of a type that will grow under these conditions. Locusts, Norway maples, elms, ginko tree, Lombardy poplars and Tree of Heaven are trees which have proven successful in very severe locations. Shrubs such as Golden-bell (forsythia), dog-woods, common and Persian lilacs, native privet, five-leaved Aralea, sumac and even the wild prairie rose thrive when enough plant food and water is furnished.

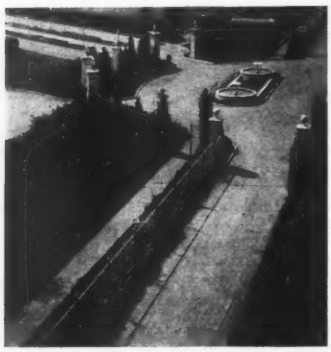


FIG. 8. THIS BEAUTIFIED GATEWAY WELCOMES VISITORS TO THE RUDOLPH WURLITZER MFG. CO. PLANT AT NORTH TONAWANDA, N. Y.

FIG. 9. AN EFFECTIVE METHOD OF BEAUTIFYING THE STRIP BETWEEN SIDEWALK AND FENCE

Green Grass Plays Important Part

Large areas of green grass bordered by flower and shrubbery beds give the feeling of spaciousness and are the foreground of the buildings framed in by trees and shrubs. An expanse of clean lawn is a beauty spot within itself and will thrive under severe conditions. Open flower beds in the middle of the lawns add greatly to the maintenance and are unsightly mud puddles a large part of the year.

Annual and perennial flower borders give life and color to the natural picture. They desire plenty of sun and require more maintenance but will repay many fold for the efforts expended. They especially desire a well drained fertile soil and respond to any favorable treatment they may receive.

Mechanical Stokers of Class A sold in March, 1932, as reported to the Bureau of the Census by 55 manufacturers, reached a total of 118 units of 24,352 hp. capacity. Of these, 79 were for installation under 10,298 hp. of firetube boilers and 39 for use under 14,054 hp. of watertube boilers. Class 4 stokers are for large commercial and high-pressure steam plants, capacity over 300 lb. of coal an hour.

Pipe Hangers and Supports Used in Modern Fabrication

Without Standard Specifications Engineers Have Designed Many Forms of Pipe Supports That Have Come Into General Use. By Henry C. Moffett*

UP TO THE PRESENT time no standards have been adopted for the manufacture of pipe hangers. All manufacturers, however, have standards of their own which they use as shop guides. In all simple hangers in which no springs are used, these manufacturers' standards are much alike, especially when the supporting materials are for piping of moderate pressures.

The American Society of Mechanical Engineers has issued a tentative code for the fabrication of hangers, supports, anchors, sway bracings and vibration dampeners, which consists of a set of minimum requirement standards. This, when adopted, is ultimately to be, a part of a code for all pressure piping. The proposed code will refer to the adopted specifications of the American Society of Testing Materials for steel, wrought iron, malleable iron and springs. It will also stipulate materials allowed for any given service; state design limitations and dimensional limitations; and set forth factors of safety to be used.

This code will be a valuable paper for all piping designers to possess, since it will contain much information on the subject, as well as many practical pointers rarely if ever found in other works.

Pipe hangers and supports are roughly divided into five classes, as follows: 1. Simple hangers. 2. Spring hangers. 3. Pipe supports. 4. Brackets. 5. Roller supports.

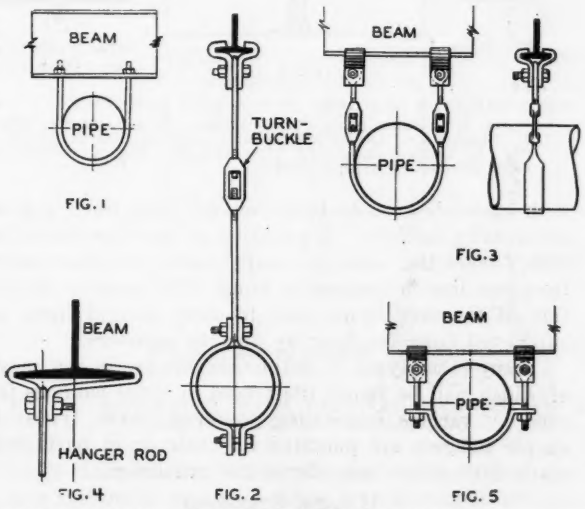
Forms of Simple Pipe Hangers

Simple hangers are those which have no springs or rollers, but which may or may not have some means of adjustment. The simplest type consists of a "U" bolt, usually threaded for 2 or 3 in. on each end as illustrated in Fig. 1. The nuts are used to adjust the height. This type is practical only when the line is to be run close under some supporting members, and when the pipe carries a low temperature fluid.

Probably the commonest type of hanger, and the one in most general use, consists of a beam clamp, rod, turnbuckle and pipe clamp, similar to that shown in Fig. 2. These cannot be used unless the line is run sufficiently far below the supporting members to accommodate the various parts. This style allows movement along the axis of the pipe for expansion, and also for side sway. Adjustment for height is taken care of by the turnbuckle in most cases. If, however, the rod is not the proper length it is common practice to use a torch in the field to cut it off and reweld to the right length.

When large pipes are to be suspended from roof trusses or floor beams, special hangers are frequently employed, such as shown in Fig. 3. These require two beam clamps, two turnbuckles, two sections of rod and a "U" bolt strap, forged round on each end and threaded. Large pipes may be hung quite close to beams with these hangers, and yet the adjustment for height is as great as in the type illustrated in Fig. 2.

Whenever possible, it is best to use symmetrical beam clamps, so that the weight of the pipe line will be equally divided between the two halves of the lower flange of the supporting beams. It is sometimes necessary, however, to use eccentric beam clamps similar to Fig. 4. If the beams are quite large and the pipe to be supported relatively small, no harm can result, but very heavy lines would tend to twist the beams and set up harmful stresses. When this condition is found, it is necessary to have intermediate beams installed from which the line may be hung.



SEVERAL FORMS OF SIMPLE PIPE HANGERS

Fig. 1. U bolt hanger. Fig. 2. Rod and turnbuckle type. Fig. 3. U hanger for large pipe close to ceiling. Fig. 4. Eccentric beam clamp. Fig. 5. Convenient hanger of eye bolts and half pipe clamp.

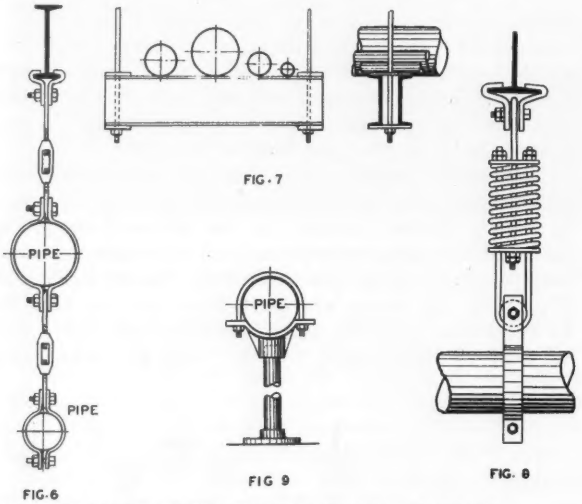
Another style of simple hanger frequently used, Fig. 5, consists of a heavy section half pipe clamp, two rods and two beam clamps. This form of hanger is useful in suspending large pipes close under beams and at the same time allows a slight movement of the line. All adjustments are made with the nuts on the ends of the rods. The pipe rests in the saddles of the hangers and may be lifted or pulled out without disturbing the hangers.

*All rights reserved by the author.

Methods of Meeting Special Problems

When two pipe lines are to be hung, one directly below the other, double hangers, Fig. 6, are sometimes resorted to, for economy. This method is not recommended, however, unless it is absolutely necessary, and especially on important lines, such as boiler feed lines and main steam lines, since it is difficult to work on the upper line without disturbing the lower line.

It is sometimes possible to support several lines on the same hanger, as shown in Fig. 7. Hangers of this kind, on which lines are laid side by side, may be found most useful in tunnels or pipe galleries, where long lines are suspended overhead. For heavy lines these are made



PIPE HANGERS DESIGNED FOR SPECIAL SERVICE

Fig. 6. Double hanger with turnbuckle adjustment. Fig. 7. Channels or angles make convenient hangers in tunnels. Fig. 8. Spring supported pipe hanger. Fig. 9. Common form of cast-iron pipe saddle.

with channels back to back, but for light lines, angles are usually sufficient. A variation of the type shown in Fig. 7 takes the form of a wall bracket on which more than one line is frequently hung. Still another variation of the same type, used to carry several lines, is supported from the floor by upright members.

Many other types of simple hangers are in use, most of which will be found illustrated in trade catalogs issued by various fabricating concerns. Some types of simple hangers are patented in whole or in part, and many innovations are offered the purchaser.

Hanger Strength

It is important to know the strength of hangers so as to be able to space them properly according to the weight of the line. All pipes should be figured as full of water, even though they are to carry compressed air or steam, as some condition may arise in operation that will flood them. Many engineers also insist on hydraulic pressure tests after pipe is in place and this imposes a great deal of weight on the lines.

Some manufacturers regularly make two weights of simple hangers; one for the lighter pipes used for low pressure work, and one for the heavier pipe lines on high pressure work, for 400 lb. per sq. in. and higher.

Proper consideration in the choice of hangers and supports is an extremely important item in the design of piping systems, and one on which the proper functioning of a system largely depends. This is especially true if a line must move due to expansion or contraction, or must absorb vibrations set up by automatic devices or the rapid flow of the medium carried. Many good designs have fallen short of perfection due to the skimping of supporting materials, whereas the investment for these materials always pays large dividends.

Pipe Movement

Spring supports or hangers are used for two reasons: to allow the line supported to move vertically and at the same time prevent unnecessary thrust on an anchorage or piece of equipment, and to dampen vibration. One such is illustrated in Fig. 8.

It is quite important in some cases to allow the pipe line to move, and still be supported on springs. Main steam headers on extremely high pressure work, even though carefully designed and having plenty of offsets and expansion bends, are still rigid and must be allowed to move freely between anchors and connected equipment, and here spring hangers are useful.

Frequently it is necessary to support a pipe line from the floor. For this purpose, most manufacturers offer cast-iron saddles which may be screwed onto an upright pipe. The pipe to be supported is held in the saddle by an inverted "U" bolt which fastens to the saddle as shown in Fig. 9.

Pipe lines which are to be hung close to walls or along a line of columns in locations which are not suited to the use of simple hangers, are either braced to the walls or columns or supported on brackets. There are no standards for such brackets.

Brackets lend themselves admirably to the use of rollers for pipe lines, and many steam lines and other high temperature lines are supported this way. Important lines must often be guided in their movements and roller guides or sliding guides may be fitted to properly designed brackets.

Roller supports for pipe lines are offered in many forms. Some of these are adjustable vertically, which is important when supporting stiff lines, as this feature gives the erector a chance to equalize the weight on each roller. Some roller supports consist of a cast-iron roller and base plate. In this style the roller itself has no axle. Usually the base plate is grooved or has a cast depression in which the roller rides, and which acts as a holder for the roller so that it will not move too far out of place.

All rollers of the axle type, when used on heavy or on high temperature lines, should have bar steel shanks. Solid cast-iron rollers of the pulley type, are not recommended except for small lines.

Care should be taken in placing rollers under heavy pipes, to see that they actually roll when the pipes move. Proper alinement of the rollers is paramount. Base plates should be securely fastened down so that they cannot possibly twist. All bearing surfaces should be smooth and of easy access.

There is a universal type of roller support on the market which has several good features. The support itself runs in a guide, and the saddle is on a swivel. This allows the pipe to move without binding.

The design or choice of hangers or supports should never be decided upon until after all the values of expansion and weights of a line are known. Properly hung lines give little trouble, and prevent leaks caused by unnecessary strains on joints.

Power Utilization

Steam Traps in Industrial Plants

SELECTION, INSTALLATION AND MAINTENANCE TO ENSURE PROPER DRAINING OF PIPING AND EQUIPMENT. BY T. H. REA*

IN AN industrial plant using steam for both power generation and process work, the total orifice capacity of all the steam traps is usually greater than the steaming capacity of the boiler plant. This fact alone makes the selection, installation and maintenance of steam traps a question of major, not minor importance.

Two primary functions of a steam trap are to remove condensate and to prevent the loss of live steam. In all too many plants the steam traps are passing the condensate but, at the same time, are wasting thousands of pounds of live steam. In other plants little steam is being wasted but process equipment is being handicapped by the presence of water and air that must be removed before satisfactory production can be obtained.

Steam trap selection for industrial plants naturally divides itself into two parts: Selection of traps for power plant and steam distribution service; and selection of traps for process and heating work.

In a high-pressure industrial power plant using superheated steam, the traps are installed to take care of emergency or unusual operating conditions. The cost of adequate and reliable trap equipment is low compared with the cost of the equipment drained or protected by the traps, hence neither quality nor capacity should be slighted in selecting traps for steam generation or steam distribution services.

DRAINING PIPING SYSTEMS

Where foaming or priming is at all common in boiler operation, internal steam purifiers or external steam separators are installed to free the steam of any slugs of water or entrained moisture thrown over with the steam. Some purifiers and all separators require a trap to remove the water as fast as it is separated from the steam. On account of the very large volumes of water to be handled, compound or piston operated traps are frequently selected for this service. Some engineers specify purifier traps having a continuous discharge capacity at least equal to the capacity of the boiler feed pumps on the theory that, if the pump control mechanism should fail the traps would be able to remove the water as fast as it is pumped into the boiler. This is hardly a safe assumption, however, and pump control should be made certain.

Against large slugs of water, a receiver separator or a special receiving tank between the separator and the trap gives the best protection. Without this storage capacity the slightest lag in trap operation would permit some water to pass over with the steam. When a receiver is used, a small trap can be installed with greater safety than can a large trap and no storage capacity. The installation of a separate receiver and trap is shown in Figure 1. The purpose of the vent line is to permit steam to escape and allow water to enter the receiver without waiting for an equal volume of steam to be condensed. Vent lines are not usually required when the trap is installed close to the receiver.

Traps draining superheated steam headers function only when steam is first turned on or when the superheat is lost. A conservative rule to follow in selecting traps for this duty is that the continuous discharge capacity of the trap should be three times as great as the amount of steam that would be condensed by the line without superheat and without pipe insulation.

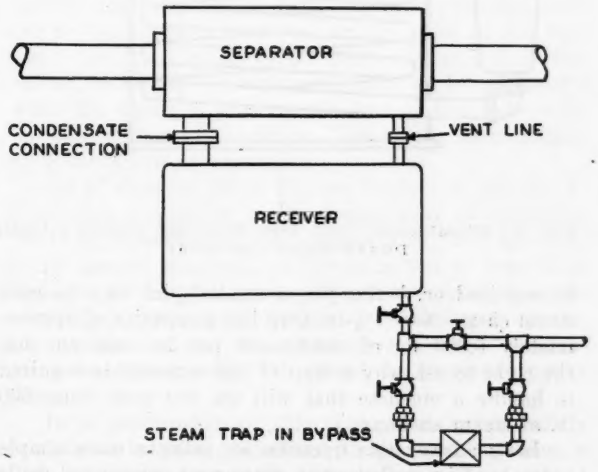


FIG. 1. SEPARATOR WITH RECEIVER DRAINED BY A TRAP GIVES SAFE PROTECTION

If there is any danger of water being carried over to a turbine or engine, a steam trap alone will not give sufficient protection. With steam velocities ranging from 5,000 to 15,000 ft. per min., any entrained water would be carried past the line leading to the trap and water would be in the turbine before the trap could function. A separator should be used in connection with the trap and here again a receiver separator drained by a relatively small trap will give better protection than a large trap installed without storage capacity in the separator.

Power plant traps may be compared with military or naval forces. They may never be called on for active war duty but they must always be ready to deliver the goods. On the other hand, carrying the simile farther, traps for process and heating work, are like civilians in that they have regular duties to perform and one day's work is much like the next.

*Armstrong Machine Works.

Trap Size for Process Work

Since the amount of steam condensed by a process unit can easily be calculated or determined from actual experiment, trap selection would seem to be a simple matter. Assuming that the trap manufacturer's capacity figures are accurate all the engineer would have to do would be to order a trap whose continuous discharge capacity was at least equal to the steam condensing capacity of the process unit. Unfortunately, it is not as simple a matter as this since factors other than the amount of condensate enter into the problem.

For instance, an eight-roll, flat-work ironer doing family work will condense not to exceed 600 lb. of steam per hour at 100 lb. pressure. Several ½-in. steam traps are on the market having a continuous discharge capacity of more than 600 lb. per hr. at the pressure indicated, yet none of these would be able to handle a machine of this type and size. In fact a 1¼-in. trap would

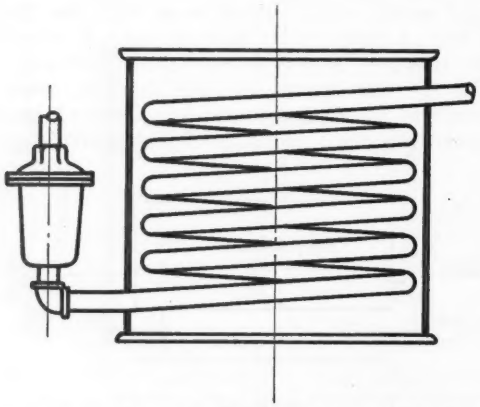


FIG. 2. SUBMERGED COIL FOR HEATING NEEDS LARGE DRAIN TRAP CAPACITY

be required or, better yet, a small ½-in. trap on each steam chest. Now 1¼-in. trap has a capacity of approximately 5,000 lb. of condensate per hr. and one has the right to ask why a trap of this capacity is required to handle a machine that will use not more than 600 lb. of steam an hour.

Let's answer this question by using a more simple example. Figure 2 shows a submerged copper coil made from 15 ft. of 1-in. copper tubing. With a liquid temperature of 78 deg. F. and a steam pressure of 5.3 lb. gage, this coal with 5 sq. ft. of surface will condense approximately 575 lb. of steam per hour. Now ordinary direct radiation at 5 lb. pressure will condense about ⅓ lb. of steam per hour per sq. ft. of surface. Thus to condense the same amount of steam as was condensed by the copper coil some 1725 sq. ft. of direct radiation would be required, equal to some 1700 lineal feet of 3½-in. pipe.

At 5 lb. pressure a ½-in. trap could easily take care of the condensate from the submerged coil but the same size trap would not be adequate for 1700 ft. of 3½-in. pipe, even though the amount of condensate should be the same in each case. In the copper coil there is good gravity drainage of condensate to the trap; furthermore the coil will contain only 1/10 cu. ft. of air which would be quickly discharged through the trap. On the other hand, with 1700 ft. of pipe, the drainage to the trap would be sluggish and the line would contain about 118 cu. ft. of air, which is more than a thousand times as much as would be contained in the coil. Only in very special cases would it be advisable to drain this much line with a single trap. There should be a trap at every low point in the line and, even with a continuous pitch, it would be advisable to install small traps at intervals of approximately 400 ft.

This discussion shows that, not only must the amount of condensate be taken into consideration but also the volume of air and the size and shape of the radiation itself.

Traps to Drain Radiation

All too frequently the discharge capacity of a trap is multiplied by three to obtain the number of square feet of radiation that the trap will handle at 5 lb. pressure (or the capacity is multiplied by 9 to get the lineal feet of 1-in. pipe). This is decidedly wrong because, in the first place, a square foot or radiation at 5 lb. pressure will condense ⅓ lb. of steam per hour after the radiation has been brought up to temperature and when the room temperature is 70 deg. F. Extra trap capacity must be provided to take care of the warming up load, when steam is turned into the cold pipes and when room temperature is considerably below normal. Last but not least, the trap should have enough capacity so that, when operating at normal load, the discharge valve will be open not more than one half of the time.

Thus for ordinary industrial radiation with good drainage to the trap, conservative practice demands that at 5 lb. pressure 1 lb. per hour of trap capacity be provided for every 1 to 1½ sq. ft. of radiation. This gives enough extra capacity to take care of the warming up load, except under most severe operating conditions.

Where the radiation consists of long lines of practically horizontal pipe such as is found in greenhouses, drykilns, and some space heating, extra trap capacity must be provided, on account of the poor gravity drainage to the trap as well as the large volume of air in the radiation itself. Furthermore, the condensate from several lines is usually handled by a single trap, which makes short circuiting possible. This is, to some extent, prevented by installing what would otherwise appear to be an oversized trap. For this type of radiation a safe rule to follow is 2 to 3 lb. of trap capacity for every sq. ft. of radiation or for every 3 lineal feet of 1-in. pipe.

Unit Heater Drainage

Since many industrial plants are installing unit heaters in place of direct radiation for space heating, a word about trap selection for unit heaters is in order. When a unit heater is delivering its normal maximum load, the trap should be open not more than one half of the time. By normal maximum load is meant the amount of steam that will be condensed with the fan operating at top speed, with full steam pressure and with the lowest entering air temperature that the heater is ordinarily called on to handle.

For a unit heater the trap must be able to open at the maximum pressure in the steam line supplying steam to the heater. But, with the heater condensing steam at its rated capacity, there will be a pressure drop through the heater and furthermore some back pressure in the return line, at least when the trap is discharging. To be on the safe side, it is advisable to

figure the pressure differential through the trap at 75 percent of the steam line pressure. Thus the trap should be able to open at steam line pressure and should have a continuous discharge capacity at least twice as great as the normal maximum load.

For example, if a heater will condense 1000 lb. of steam per hour when supplied with steam at 100 lb. pressure, a 100-lb. pressure trap will be required that has a continuous discharge capacity of 2000 lb. per hour at 75 lb. pressure. Somewhat greater allowances should be made in selecting traps for low-pressure unit heaters because a pressure drop at low pressure will have a greater effect on trap capacity than a proportionate pressure drop in a high-pressure trap.

Flexible Coupling Lubrication

SINCE maintenance of machinery in perfect alignment, horizontally and longitudinally is not always possible, flexible couplings are necessary and have been developed in various types to a high degree of perfection. But the very name, flexible, presupposes some movement of parts on one another and that implies need for lubrication. Different types need different lubricants but good lubrication is necessary in all types if best performance is to be secured, even though the amount of lubricant required is small.

Types of Couplings

In all cases, provision is made for horizontal play parallel to the axes of the shafts, for motion due to slight angular misalinement and for end play. Five general types of design are employed: (1) Geared devices having internal and external meshing gears, the external attached to the shaft ends, the internal to the coupling casing; (2) floating keys which bridge between slotted disks on the shaft ends and are held in place by the casing; (3) flexible pins joining disks on the shaft ends; (4) flexible springs connecting disks on the shaft ends and held in place by a retaining ring and the casing or by the casing alone; (5) cross type with keys or slots at right angles in an intermediate member, meshing with slots or projections on disks fastened to the shaft ends.

Lubricants Needed for Gear Type

In the gear type, Fig. 1, teeth are permanently in mesh, the teeth and spaces serving as rings of loose-fitting keys and keyways, with spherical surfaces to allow rocking for angular movement. Casings are sealed against dirt and water ingress or oil egress by packing rings and are given a charge of oil sufficient, when thrown to the outside of the casing by centrifugal force, to envelope the gear teeth in an oil bath. Pumping action due to movement of the teeth on each other will cause circulation and maintain the oil film. The oil used should be of such grade as to be liquid under the temperature of operation yet heavy enough to maintain a film under the pressure existing between teeth. For light service at ordinary temperatures a viscosity of 1000 seconds Saybolt at 210 deg. F. is suitable while for heavy duty or in cold locations the viscosity may be 100 seconds Saybolt. Where loads are heavy and temperature is high, even a heavy gear compound may be required. In any case the charge in the casing should be maintained sufficient to ensure that all gear teeth are covered their full depth when the coupling is running.

Floating-Key Lubrication

Floating-key couplings, Fig. 2, have much the same conditions as the gear type, the motion being between

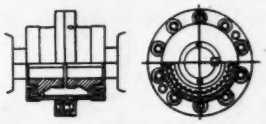


FIG. 1. FAST GEARED-TYPE OF COUPLING

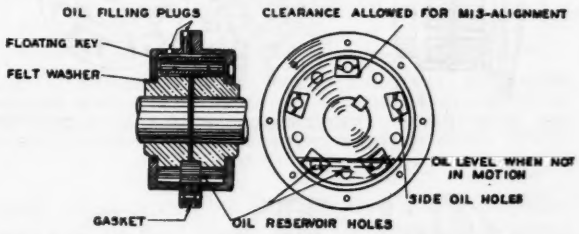


FIG. 2. NICHOLSON FLOATING-KEY DESIGN OF COUPLING

keys and keyways; hence keys should be bathed in oil. Distribution of lubricant is assisted by holes drilled lengthwise of the keys with cross branches leading to the surfaces that bear on the sides of the keyways. In some types an oil level is provided in one end of the casing, the right amount of oil being charged when the casing is filled to the level of that hole, with the hole at its lowest position. The hole is then stopped by a cap screw or pipe plug.

Oil of viscosity 300 to 500 sec. Saybolt at 100 deg. F. is suitable, depending on the temperature of operation, the lower viscosity for low temperatures. For this type as for geared couplings, as low pour test as possible is desirable so that the oil may distribute quickly from its standing position at the bottom of the casing to operating position around the circumference when the coupling is started cold. Oil should be renewed once a year.

In a modification of this type, steel spring rollers are placed between projections that extend out from a disk attached to one shaft and projections that extend in from the casing shell attached to the other shaft. A screwed cap closes the casing end and the entire casing is filled with a medium hard grease.

Flexible Pin Details

Flexible pins have one end held fast in one disk the other end moving in a bronze or graphited bush-

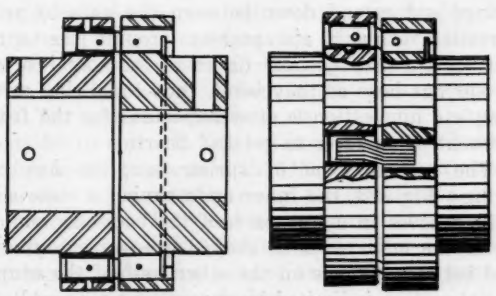


FIG. 3. FRANCKE LAMINATED-PIN COUPLING CONSTRUCTION

ing which is mounted in the other coupling disk as in Fig. 3. Between these ends are pivoted laminated springs which take up the motion due to misalinement in any direction. A retaining ring holds the pins in place. Graphited bushings give some lubrication, usually sufficient for light service but, for heavy duty, it is recommended that the coupling be enclosed in a casing and supplied with oil sufficient to bathe the pins when running.

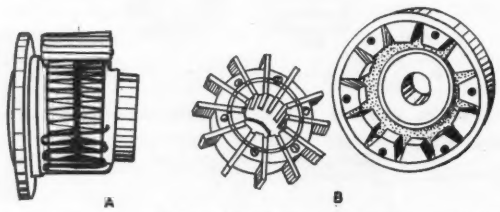


FIG. 4. A, FALK FLEXIBLE-SPRING DESIGN. B, BROWN, RADIAL-SPRING COUPLING

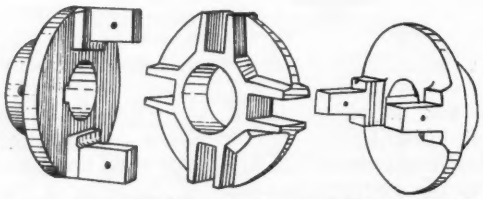


FIG. 5. FRANCKE SLOTTED DISK AND LUGS DETAILS OF CROSS-TYPE

For extra heavy service or where misalinement is liable to be considerable, a modification of this type has a set of pins held in each disk, the free ends engaging in bushings in a floating ring. The double set of pins and movement of the ring give added flexibility, an outside, oil-charged casing being essential.

Scoops on the circumference of the floating ring, the mouths pointing in the direction of rotation, gather up oil from the casing and carry it to the pin bearings in the ring so that the depth of oil in the casing need not extend to the pins.

The single row pin bushings may be lubricated with moderately heavy grease for high speed or heavy duty work.

Flexible Spring Types

Flexible springs are used in two designs; one has springs placed into grooves on the circumference of the hubs of that and the mating portion of the coupling, Fig. 4A. The springs are parallel to the shaft axis, are covered by a sealed casing and are lubricated by grease which is packed to fill all spaces around the springs and extend down between the hubs to prevent formation of any air pockets around the springs. Grooves are shaped with curved surfaces against which the springs bear as they bend, thus equalizing stresses. Complete lubrication is most important for the free adjustment of surfaces to get full bearing.

The second form of spring coupling has radial springs, Fig. 4B, the inner ends having a close sliding fit in grooves in a hub on half the coupling and bearing at the outer ends in shaped grooves cut in a ring held between flanges on the other half of the coupling. Radial motion is limited by a retaining ring. All space in the coupling is filled with grease to give free sliding of springs against bearing surfaces and between laminations.

For the cross type, Fig. 5, in which motion is between plane surfaces, holes are drilled radially in each lug with branches crosswise of the lugs to conduct heavy mineral oil to the rubbing surfaces. Casings enclose the moving parts and oil is carried sufficient to flood all bearing surfaces when the oil is thrown out against the casing by centrifugal force.

For all types of flexible couplings it is important that adequate lubrication be maintained and inspection should be made regularly, though, unless there is indication of leakage from the casing, opening up for cleaning and refilling is necessary only at infrequent intervals say 6 mo. to a year.

Undersize Wiring

WHEN PLANNING distribution wiring, the results of using wire too small for the load should be kept in mind. Small wire costs less to be sure, but the cost of larger wire and conduit after all increases total cost comparatively little more than for smaller wire, since installation labor, switches and fixtures cost about the same either way.

On the other hand, difficulties in motor operation from low voltage and varying voltage due to line drop, also loss in effective illumination from lamps and variation of lighting intensity are factors which result in continuous loss due to inconvenience to workers and slowed down production.

The effect on lighting is well brought out by data from the Nela Park Engineering Dept. of General Electric Co. Obviously, with no current flowing, voltage all along the line will be the same as at the distribution board, say 117 v., regardless of wire size. If, now, on a circuit of No. 14 wire, 500-watt lamps are turned on at 40, 50 and 60 ft. from the board, voltages at the lamps will be about 112.5, 112 and 111.5, allowing 2 v. drop on feeders. If, however, the lamps are at 80, 90 and 100 ft. from the board, the voltages will be, approximately 109.5, 109 and 108.5. If all six lamps are turned on, they burn at voltages of 105.5, 104, 103, 102.5, 102 and 101.75 v. or at considerable undervoltage. This will be due in part to extra drop in the feeder but mostly to drop in the No. 14 distribution circuit.

For 10 per cent undervoltage, the lamps will receive but 84 per cent of normal energy, 11 per cent being lost in the wiring. Their light effect will be only 68 per cent of normal, so that while cost of operation will be reduced to 86 per cent of normal, cost per unit of light will increase to 128 per cent of normal.

Similarly and to greater degree, motor speeds, output and cost per unit of product will be affected.

Figuring from these and other data, the conclusion is reached that No. 12 wire in circuits 50 ft. long should be limited to 1000 w. initial load, while for the same load and circuit length 100 ft. No. 10 wire should be used. This will keep voltage up to 115 v., with 117 v. at the distribution board and will maintain normal operating voltage at lamp sockets or motor terminals.

FURNACE bottom for the 778 hp. B. & W. cross-drum boiler at Buda Mfg. Co.'s plant, Harvey, Ill., is hopper shaped, formed by two banks of water tubes covered with Bailey smooth faced metal blocks.

Redevelopment of Roanoke Rapids Hydroelectric Plant

By Replacing a 3200-hp. 92-in. Fixed Blade Propeller Runner with a 96-in. Runner Designed for Limited Blade Angle Adjustment, Capacity Has Been Increased by 500 kw. at Low Cost.

BY
ALAN G. CHERRY*

ANY POWER system that includes hydroelectric plants requires careful study of these water power developments from time to time, as the system load increases, to insure that the system as a whole makes the best utilization of the power resources at its disposal. A recent and interesting result of such study is the redevelopment of the comparatively modern automatic hydroelectric station of the Virginia Electric and Power Co. at Roanoke Rapids, N. C.

Power development of the Roanoke River in the vicinity of Roanoke Rapids, North Carolina, dates back to the year 1812 when the Virginia Passenger & Power Co. constructed an 8-mi. navigation and power canal from Roanoke Rapids to Weldon, N. C. The title of this company later passed to the Roanoke Development Co., which constructed two small power plants on the canal, one at Roanoke Rapids and one at Weldon.

In 1895, the Roanoke Rapids Power Co. was formed, and constructed a new power canal with timber crib diverting works, which divided the river flow so that one portion passed into the power canal and the other down the main river. A large proportion of the rights in this canal was deeded to local manufacturing companies for power and industrial purposes. The power company in 1906 and 1907 improved the development by enlarging the canal, replacing the timber crib structures with concrete and completing a concrete diversion dam entirely across the river. These improvements increased the head by 2½ ft. and during low water periods diverted practically all the river flow into the canal. At this time also, the power company built its first hydroelectric power plant and from then until 1919 gradually added to its hydroelectric capacity and also installed some steam relay capacity.

Details of Plant Before Redevelopment

Previous to 1924, the power demands on the canal required about 2200 c.f.s. of water, which corresponds to the river flow which is available about 88 percent of the time. A study at that time indicated that it would be economical to install sufficient additional capacity to increase the utilized flow to about 3200 c.f.s., which flow is available 75 per cent of the time. Accordingly, in 1924 a new power station was constructed, which contained one vertical-shaft hydroelectric unit rated at 3200 hp. under 30 ft. net head. The 92-in. water wheel runner of the unit was of the propeller type with six fixed blades. This new unit was arranged for full automatic control from the switchboard in the old power station. About the time the new power station was completed the Roanoke Rapids Power Co. was purchased by the Virginia Electric and Power Co. of Richmond, Va. and the old and new power stations became parts of that company's power system.

*Engineer, Hydraulic Division, Stone & Webster Engineering Corp.

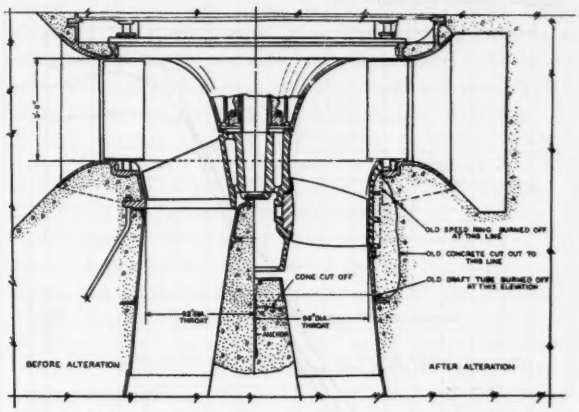


FIG. 1. DIFFERENCES BETWEEN ORIGINAL AND NEW WATER WHEEL AND SETTING. AT LEFT—HALF-SECTION OF 92-IN. WATER WHEEL BEFORE ALTERATION; AT RIGHT, HALF-SECTION OF 96-IN. WATER WHEEL AFTER ALTERATION

Subsequent to 1924, there was progressive improvement in the design of propeller type runners, including particularly the development of the adjustable blade runner. The power company, keeping in step with these improvements, authorized in 1930 an investigation to determine whether or not the installation of an adjustable-blade runner at the Roanoke Rapids automatic station would be justified by the resulting increase in output.

Analysis of Redevelopment Possibilities

It was obviously impracticable to provide a mechanically-operated, adjustable-blade runner, since this would have required an entirely new turbine. Three other principal possibilities, however, were analyzed as follows: installation of a new 92-in. fixed-blade propeller runner of improved design; installation of a new 92-in. manually-operated movable-blade propeller runner; installation of a new 96-in. fixed-blade propeller runner with the vanes arranged for limited field adjustment of the blade angle.

The first scheme was lowest in cost but yielded the smallest return in increased capacity and energy. The second scheme yielded relatively small increase over the first and, in addition, was not entirely practicable, since it introduced the manual operation of runner vanes into a station otherwise operated entirely automatically.

The third scheme, although the most expensive, yielded the largest increases in capacity and energy in proportion to cost. It was estimated, on the basis of manufacturers' guarantees, that the unit capacity would be increased at least 400 kw. by the installation of the 96-in. runner and that the average annual output would be increased by at least 3,000,000 kw-hr. For all schemes the estimated increment costs of the additional capacity and energy were extremely low.

Based on the results of this study, it was decided

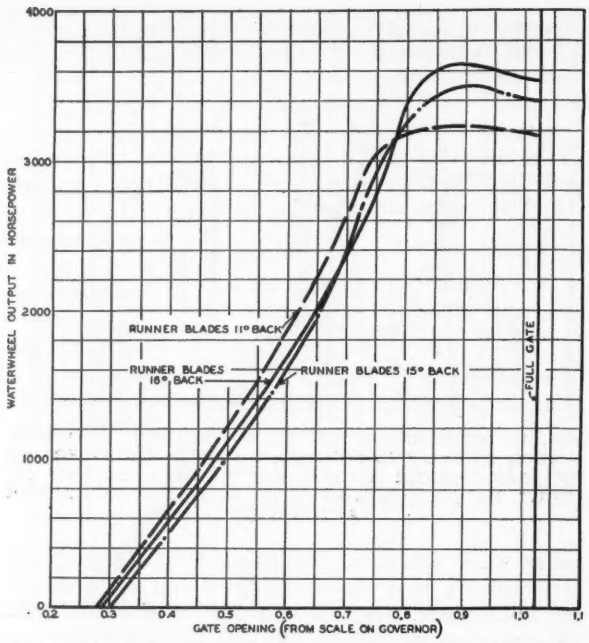


FIG. 2. WATER WHEEL OUTPUT GATE OPENING CURVES, 28 FT. NET LOAD, BASED ON CAPACITY TEST OF NEW 96-IN. RUNNER, ROANOKE RAPIDS

to proceed with the installation of the 96-in. runner in place of the existing 92-in. runner. The six vanes of the new runner are adjustable to three positions; that is, they can be set at angles of 11 degrees, 15 degrees and 16 degrees back from the vertical. The 16-deg. back position was expected to develop the most power but was also expected to be the most subject to pitting. Adjustment to the other two positions was provided so that, in case evidence of excessive pitting developed, the vanes could be shifted to reduce pitting tendency.

Increase in runner diameter required only minor structural changes in the existing water wheel setting in the upper portion of the draft tube and in the vicinity of the discharge position of the speed ring. Differences between the original and new setting are shown in Fig. 1. These changes necessitated taking the machine out of service for an appreciable length of time. To reduce the outage time to a minimum, a schedule was carefully worked out so that sufficient time would be allowed for the structural changes and, at the same time, all necessary new material would be on hand for installation when required. This necessitated complete coöperation between the power company, the water wheel manufacturer and the engineers, particularly since several of the existing water wheel parts, such as the main shaft, guide vanes and lower distributor ring, had to be shipped back to the water wheel manufacturer's plant for alterations or for use as templates. The schedule as finally worked out contemplated taking the unit out of service on July 6, 1931 and returning it to service on August 8. Actually the unit was taken out of service on July 5, was placed back in preliminary operation on August 5 and was in commercial operation on August 8, as scheduled.

Detail construction operations did not present any particularly difficult problems, beyond the necessity for adhering closely to the pre-arranged schedule. A woodsheeting and earth-fill cofferdam was first constructed across the draft tube outlet and the generator and water wheel were dismantled in order to release for shipment to the water wheel manufacturer all the necessary parts. The upper part of the draft tube liner and the draft tube cone were cut away and the inner rim of the speed ring was burned off. The new throat ring and draft tube liner were installed, lined up and grouted in place, the new liner being welded to the original draft tube liner. By the time the new concrete had set sufficiently the new runner and the altered parts of the turbine had been received from the manufacturer and were promptly installed. The water wheel and generator were re-assembled, their alignment and clearances checked and they were placed in preliminary operation on August 5, one month after the station was taken out of service.

Results of Tests on Remodeled Plant

During preliminary operation, capacity tests were run to determine the power-gate curves for each of the three positions of the adjustable runner vanes. The results reduced to 28 ft. head are shown in Fig. 2. The increase in unit capacity is shown in Fig. 3, where the unit capacity in kilowatts is plotted against gross head for both the original 92-in. runner and the new 96-in. runner. It will be noted from a comparison of these curves that the maximum increase of power is about 660 kw. and that for the greater portion of the operating head range the increased capacity is more than 500 kw. Based on the results of these capacity tests a revised estimate of the annual increase of energy output indicates that more than 5,000,000 kw-hr. of additional energy may be expected. Actual benefits from the installation of the new runner will thus apparently exceed by a substantial amount the original estimated benefits on the basis on which the redevelopment was justified. After several months of operation, there is not yet sufficient evidence of pitting to warrant a change in the adjustment of the runner blades from the position of maximum capacity.

Stone & Webster Engineering Corp. handled the engineering and construction work in connection with the original station and redevelopment.

Original water wheel unit and the new runner were furnished by the Wm. Cramp & Sons Ship & Engine Bldg. Co., and the engineers of the successor company, the I. P. Morris Department of the Baldwin-Southwark Corp., coöperated fully in the redevelopment study.

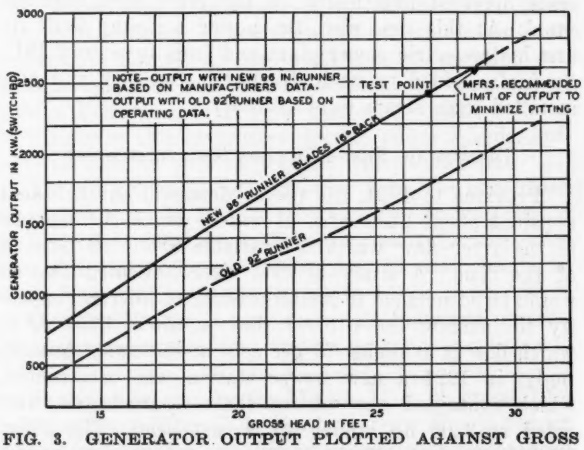


FIG. 3. GENERATOR OUTPUT PLOTTED AGAINST GROSS HEAD FOR ORIGINAL 92-IN. RUNNER AND NEW 96-IN. RUNNER AT ROANOKE RAPIDS

Off Duty

THE GREEKS were an imaginative people. Not particularly inclined towards industry they spent much of their time cooking up new exploits for their many Gods; they were never at a loss for an explanation of things. If it thundered, Jupiter was grouchy and was hurling thunderbolts; if it rained some god or other was weeping over disappointment in love or something of that sort; if the stock market crashed, it was the inevitable consequence of over-speculation in golden fleece; indeed, they knew everything. Even the stars were perfectly obvious to them. They were never confounded by high powered cosmological hypothesis of space-time curvature and receding nebulae. If they saw a new star in the sky which had not been explained before, they made up a perfectly good story about it without delay. The sky, to them, was a very livable place, peopled by all sorts of creatures good and bad, endowed with the same shortcomings and weaknesses as those on earth. Usually they were transfixed there because of something they had done on earth.

Take Arcturus for example. Arcturus, as you know, is one of the giant stars measured by Professor Michaelson some years ago; it is some 27 million times larger than our sun. Such matters—size, distance, composition, didn't bother the Greeks. To them Arcturus was Arcus, son of the King of Arcadia. One day while he was out in the woods with his air rifle, it appears he pursued his mother, who had been transformed into a bear by Zeus. Zeus, you see, was something of a necromancer himself. Well, the bear mother finally took refuge in the temple of Zeus and the God, in order to prevent matricide, transported both mother and son to the heavens. There they are today—Arcturus is in a direct line with the tail of the constellation of Ursa Major (the great bear).

Now all this is very fine and there is no telling how much further the Greeks would have gone had they continued their imaginative gymnastics, but somehow they tired of it and unfortunately for us went into the restaurant business. That was a sad day indeed.

With the Greeks out of the field, there was nobody to worry over the stars except the scientists who immediately threw out all Greek theories as so much bosh. Naturally enough, the Greeks didn't like this, so ever since, they have retaliated by painting toast with a brush and indulging in other similar nefarious practices in their hash dispensaries.

Well, if the Greeks were good in the use of their imaginations the scientists were not slouches either and before long had the stars doing things the Greeks never dreamed of. The Great Bear instead of running away from Arcus in one direction as the Greeks had it, according to the scientists, was running in six directions at once, so fast that some day it would meet itself coming back. When the Greeks heard of this, they immediately placed a curse on the human race by inventing the "minute steak." The scientists had only begun, however; not content with inventing new theories about the stars they decided recently to put them to work. How? Well, consider Arcturus again.

First, however, let us tell you something about our own much maligned and misunderstood city—about the Century of Progress Exposition to be held here in 1933. It is soothing, in these turbulent times, to know that there is at least one place in this world where people go about their work with high hope and an enthusiasm born only of noble purpose and high ideals. While the rest of the world is engaged in the sordid undertaking of patching up the wrecked hulk of our economic ship so that it will at least float again, a small group of practical idealists are busy at work, planning and constructing on the lake front of the City of Chicago, a project of magnificent proportions and of amazing artistic beauty. For strange as it may seem, at a time when nearly every organization in the world is passing through a financial crisis, and in face of the difficulties which have always beset previous "world's fairs," the Chicago "Century of Progress," to be opened next year, is in a most excellent position, financially, as well as in point of progress.

Now, don't be impatient, we realize you want to know what all this has to do with Arcturus, or the Greeks. We'll get to that. Greek restaurants by the way are taboo at the exposition. But to get back to our story. Among the numerous buildings already completed or nearing completion, one of major importance is the Science Group. Now it has become the custom, in opening an exhibit of this kind, formally, to have some distant dignitary—the president, or King George or Marlene Dietrich—press a gold plated electrical button. This always makes good publicity and enables the button pushers to pass the astonishing fact on to their grandchildren.

To the scientists in charge of the Hall of Science at the Century of Progress the idea of having a mere president or king or even a ravishing movie actress open the exhibit, had little appeal. The Hall of Science, they claimed, should be opened not by a mere human celebrity but by something that was of some consequence in the Universe. So they selected a star,the giant Arcturus, to press the button which will formally open the Science Exhibit.

To carry out this unique plan, arrangements for harnessing star power already have been made by Dr. F. R. Moulton, and Professor Henry Carew. At 9 o'clock on the night of June 1, 1933, the light from Arcturus, high up in the sky, a little east of south, will be focused on a photoelectric cell by the 40 in. telescope at the Yerkes observatory at Williams Bay, Wis., and the current so produced will be amplified and sent to Chicago where it will actuate the switches in the Hall of Science.

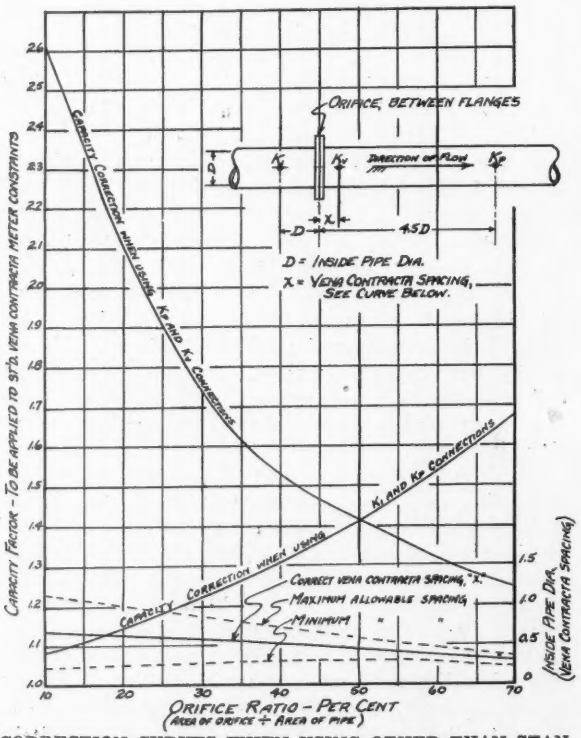
Arcturus is just about 40 light years away from us. Thus the light energy which will actuate the switches at the Century of Progress on June first of next year started on its earthward journey in 1893, the year of Chicago's other famous exposition. It is fitting, therefore, that Arcturus should be the star selected for this purpose.

Now, of course, to those who know about photoelectric phenomena this proposed use of Arcturus' light is as simple as stepping on the gas in the family chariot —a trifling matter of quantum mechanics, but no matter how simple the trick is to the scientists, at least 99 per cent of the crowd at the opening of the Exposition will gasp at the audacity of man's harnessing star power to light the lamps and start the machinery whirling at the Science Exhibit. Thus, the modern scientist goes the Greeks one better; the Greeks explained Arcturus' presence in the sky but our modern scientist puts him to work. Maybe it is well that the Greeks went into the restaurant business.

Readers' Conference

Flow Meters with Variable Capacity

IN THE MARCH 1 issue of Power Plant Engineering, under the subject of Steam Flow Meter with Variable Capacity, R. E. Thompson describes the use of condensers at different elevations as a means of increasing the accuracy and range of flow meters when widely varying rates of steam flow are encountered. While condensers at different elevations may be used to increase the range of a steam flow meter, the calculations involved in converting the recorded differentials into actual amounts of steam may prove to be quite laborious. Furthermore, such a system can be used only when measuring the flow of a vapor, such as steam, which is condensable at ordinary temperatures. An integrator on a flow meter with this arrangement would be worthless for a hook-up other than with the standard condenser connections.


ORIFICE BETWEEN FLANGES
DIRECTION OF FLOW
D = INSIDE PIPE DIA.
X = VENA CONTRACTA SPACING, SEE CURVE BELOW.
4.5D
CAPACITY CORRECTION WHEN USING K1 AND Kv CONNECTIONS
K1 AND Kv CONNECTIONS
CAPACITY CORRECTION WHEN USING
CORRECT VENA CONTRACTA SPACING, "X"
MAXIMUM ALLOWABLE SPACING
MINIMUM
CAPACITY FACTOR - TO BE APPLIED TO STD. VENA CONTRACTA METER CONSTANTS
INSIDE PIPE DIA. (VENA CONTRACTA SPACING)
ORIFICE RATIO - PER CENT (AREA OF ORIFICE ÷ AREA OF PIPE)

CORRECTION CURVES WHEN USING OTHER THAN STANDARD K_1 AND K_v PRESSURE CONNECTIONS

Pressure differentials vary as the square of the flow. In a meter having a capacity of 75,000 lb. per hr., a differential of 50 in., and an auxiliary low-pressure condenser 40 in. above the high-pressure condenser, steam flow rates of 70,000 lb. per hr. and 100,000 lb. per hr. would produce meter readings of 26.8 per cent and 99.0 per cent of full scale, respectively. The calculation of actual flow from a large number of such readings would be somewhat tedious.

The following method is simpler and may be of interest to those who desire to have two or even three flow capacities with the same orifice and meter installation. This arrangement will work with any liquid, gas or vapor which may be measured by an orifice meter. A single correction factor may be calculated for each range and it will apply to all rates of flow within its range. Thus the tedious procedure of calculating the flow for each different chart reading may be eliminated and a meter with an integrator may be used by applying a single correction factor for each range.

Let us refer again to the preceding case of a 50-in. differential meter and an orifice installation such that a flow of 75,000 lb. per hr. produced maximum chart reading. Let us assume that the ratio of the orifice area to the pipe area (orifice ratio) is 40 per cent and that the pressure connections for the meter are at K_1, one pipe diameter upstream and at K_v, the vena contracta on the downstream side of the orifice. Incidentally, for an orifice ratio of 40 per cent the vena contracta is at a distance 50 per cent of the pipe diameter below the orifice. At a point, K_p, 4.5 pipe diameters below the orifice, the average velocity of the flowing fluid will be practically the same as it is at K_1. Pressure at K_p will be less than that at K_1, however, due to the friction loss in the orifice installation, but will be greater than the pressure at K_v, due to the lower velocity at K_p.

Designate the pressures at K_1, K_v and K_p as P_1, P_v and P_p respectively. The pressure differential $(P_1—P_p)$ varies as the square of the flow, but is less than the pressure differential $(P_1—P_v)$; therefore the capacity of the meter may be increased by using pressure taps at K_1 and K_p. With the orifice ratio of 40 per cent, this increase in meter capacity is 30.8 per cent so that the correction factor to be applied to the original meter constants is 1.308, and our new meter capacity is 98,100 lb. per hr.

Since both of the pressure differentials $(P_1—P_v)$ and $(P_1—P_p)$ vary as the square of the flow, then the differential $(P_p—P_v)$ will also vary as the square of the flow; therefore, the range of our meter may be changed again by using K_p as the high-pressure tap and K_v as the low-pressure tap. In this case, the increase in meter capacity is 53.0 per cent instead of 30.8 per cent, so that the correction to be applied to the original meter constants is 1.53 and the maximum capacity of the meter is 114,800 per hr.

The accompanying curves are made up for different orifice ratios and may be of use to those interested in the above. The capacity factors shown are to be applied to meter constants with the standard meter connections at K_1 and K_v.

There are other devices on the market for changing the capacity of a flow meter installation, such as the variable orifice and interchangeable mechanisms within the meter. Flow meter manufacturers will gladly furnish information regarding such products. A combination of more than one capacity-changing device may be used for still greater flexibility but this practice introduces complications which may be objectionable.

Du Pont Rayon Co., Old Hickory, Tenn.
J. L. HUDSON, Test Engineer.

Did the Generator Reverse?

As ALL POWER station operators who are familiar with direct current generators know, the occasion often arises when it becomes necessary to speak of the generator reversing. This, however, does not really happen. What does take place is a reversal of the polarity of the fields. The following incident well illustrates how the meaning can be misconstrued:

A young man who had been working in a station where there were several alternators was transferred to a station that had in addition to several alternators one direct current generator. This d.c. machine furnished current for an electric railroad, one other d.c. machine some three miles away on the other end of the line being run in connection with this one to keep up the voltage.

A close watch had to kept of the voltage of these machines as they were both compound wound and unless it was, one or the other would drop the load it was carrying, the other picking it up. When this happened, this machine would build up its own voltage sufficiently to overcome that of the other generator, thereby sending current through the series fields in the reverse direction with consequent reversal of the polarity. The ensuing interruption, of course, caused delay to the service until the machine could be got back on the line. This was especially so when the machines were first started up in the morning. All who are familiar with this phase of the work know how the voltage drops off as the fields heat up due to the increased resistance of the windings. This was explained to the new operator and he was instructed to keep a close watch of it, otherwise there would be trouble.

After the new man had been on with the regular operator for a few days he was left alone. Several days elapsed and as everything went along well he neglected to keep as close a watch of the d.c. voltage as was necessary. Soon, however, something happened. The first inkling of trouble he had was when the brushes commenced to arc badly and at the same time the belt commenced to slip, with the accompanying screech that always goes with a slipping belt. This was all due to the voltage of the other generator being higher and overcoming this one and sending current through the series winding in the reverse direction, thereby reversing the polarity of the shunt fields.

Before anything serious could happen, however, the breaker opened, this all happening in a very short space of time. The operator not knowing just what had taken place and the voltage of the generator being up, he closed the breaker again but this instantly opened again. It might be well to state that the voltmeter used was one of the older type which did not indicate when direction of the current reversed.

As the breaker would not stay in, due, as he supposed, to trouble on the line, he called the load dispatcher and told him there was trouble on the line outside. The load dispatcher, knowing the generator at the other end of the line was all right, commenced to question him as to what was wrong and finally asked him whether the generator was not reversed. "Oh no," the operator replied, "Of course not; it is still running in the same direction!"

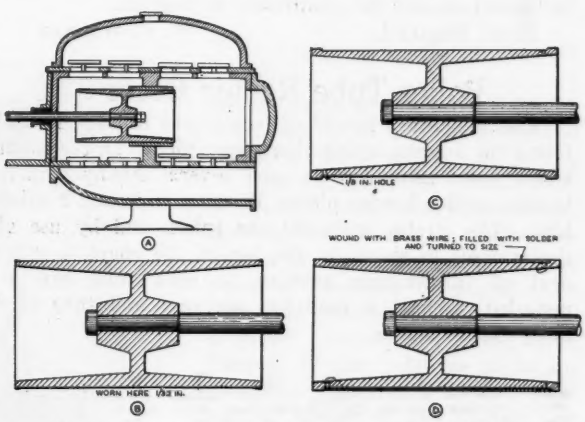
Needless to say, this proved to be the trouble and after the fields, or rather their polarity, was changed everything was all right again. To change the polarity of a compound wound generator, remove the leads from brushes, close the main switch for about a minute and reconnect leads. The same result can be obtained by removing the brushes instead of disconnecting the leads but this some times entails too much work. It is sometimes recommended to do both.

Brunswick, Maine. LEON L. POLLARD.

Emergency Pump Repair Job

IN A SMALL plant some years ago the service pump, a 10 by 5 by 12-in. duplex, got its supply from a pond about 600 ft. away. The pump in question ran night and day for the whole week but was idle on Sunday.

Starting up one Monday morning, this pump refused to draw water. Careful examination did not reveal any disorder. The pond from which this water came had been known to have eels in it, and many times they were found in the pump. Naturally, we all came to the conclusion that the suction pipe was blocked off with eels. Breaking the suction line in several places and putting rods through the pipe it was found perfectly clear. The



STEPS IN THE EMERGENCY REPAIR OF A PUMP PLUNGER

pump was of the style shown in Fig. A, and it was found that each plunger was worn down for the entire length of its stroke about 1/32 in. as shown in Fig. B, which, of course, was the cause of the trouble.

No such thing as getting new plungers was possible and oxy-acetylene or electric welding was unheard of at that time, but we had on hand some ⅛-in. brass spring wire that was used for making pump valve springs. The plungers were put in the lathe and a cut taken off them for nearly their entire length. They were then given a coat of solder and while still in the lathe and at slow speed the ⅛-in. brass wire was wound around them. To hold the ends of the wire, holes were drilled at each end and the wire passed through and turned over on the inside of the plungers.

The whole thing was given a good coat of solder which made the whole one solid mass. We then took light cuts off them in the lathe until they were down to standard size.

After the pump had been reassembled and started up, it gave splendid service for years afterwards.

Wabana, Newfoundland J. B. PETRIE.

Air Compressor Explosion

A NUMBER OF AIR compressor explosions which have occurred have been due to the air becoming so heated as to ignite the oil vapor carried over from the compressor, this oil vapor being derived from the compressor lubricant. Using the minimum quantity of a high grade oil will reduce the danger of explosion. Thorough cooling of compressors is important; any reduction in cooling efficiency means overheated air. The cooling water must flow freely, and the water jackets not be scaled. It is also important that the air be filtered; if impurities are carried into the compressor, they will not only cause abrasion but will also clog up the various passageways, impeding the air flow. This will cause overheating of the air and will lag the walls hindering the heat transfer to the cooling water. A safety valve is used to guard a compressor against excess pressure, so why not guard against excess air temperature which is probably the cause of most explosions? It is possible to fit a fusible plug in the air line as it leaves the compressor, so that this will melt if the temperature of the air rises above a certain point.

This plug should be arranged so as to melt at a temperature just below the flash point of the oil. It should be located as near the compressor as possible.

Herts, England. W. E. WARNER.

Boiler Tube Repair Record

FOR KEEPING a record of boiler tube repairs, I have found the accompanying chart convenient. In the plant where I am employed we have several 200-hp. boilers having outside header plates, 12 tubes wide and 9 tubes high. The circles represent the tubes, and by use of the symbols as shown at the top of the chart, a great deal of information relative to each tube can be recorded, a chart is used for one year and then filed away for reference.

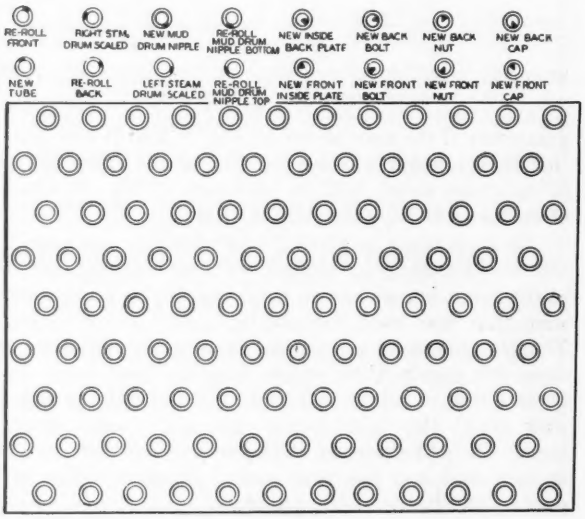


CHART USED TO RECORD BOILER TUBE REPAIRS

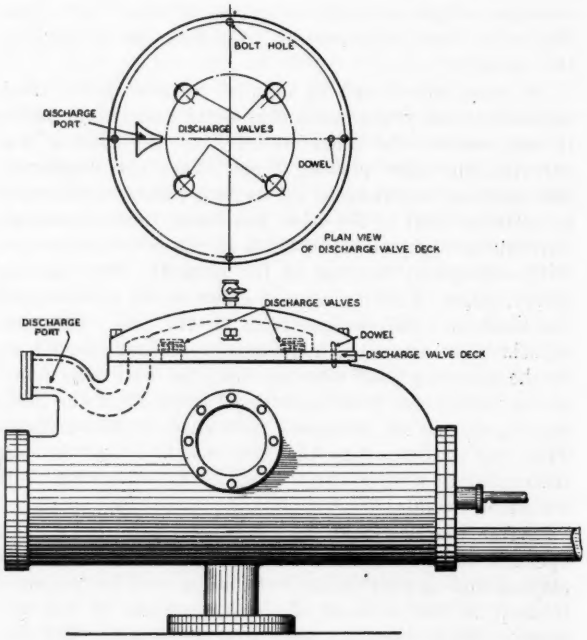
Outside the outer circle a number indicating the month of the year may be placed opposite the segment of the circle to show the approximate date of any given repair.

Pawtucket, R. I. H. P. STORER.

Precaution in Reassembling of Duplex Pumps

RECENTLY the water end of a duplex pump was dismantled for repair work and trouble occurred after this pump was reassembled and placed in operation. This trouble was of a type that I believe has occurred many times and bringing this to the attention of the readers together with a method for its prevention may prove to be of some benefit.

The pump was of the type that had four bolts holding the discharge head and discharge valve deck in place. When the time came to put the discharge valve



ELEVATION AND PLAN OF PUMP VALVE DECK

in position it was not noticed at the time that this could be placed in four different positions and still have the bolt holes line up right. As the repair job was being done in a dark place and in a hurry, the deck was put back exactly opposite from the correct way, that is, the discharge port in the deck was at the opposite end of the cylinder casting from the port in the cylinder casting with which it was supposed to line up.

When the job was completed and the pump started, the engineer noticed leakage around the discharge head but thought it was merely a matter of tightening down a little more. This he did. In several seconds a piece about 6 in. square blew out of the casting of the head. On taking the pump down again the trouble was found. It was also noticed that the bolt holes would have lined up if the discharge port had been placed at either side as well as in the incorrect position in which it had been placed.

To guard against any such future occurrence, a dowel was tapped into the discharge valve deck and a dowel hole drilled and reamed in the cylinder casting at the opposite end from the discharge port. When putting this deck in place now, it will only go on in the correct position.

West Roxbury, Mass. HARRY M. SPRING.

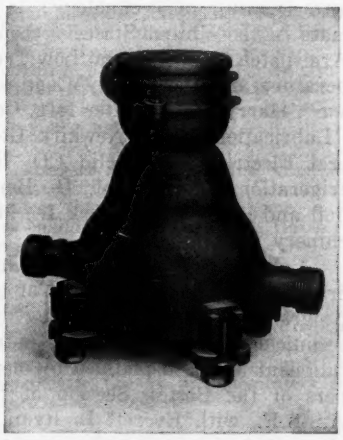
New Equipment

New Water Meter

RECENTLY, the Worthington Pump and Machinery Corpn., Harrison, N. J., has added Model GA to its line of meters designed especially to be accurate at extremely low flows as well as for the rest of its range up to high flows. It is furnished in sizes from ⅝ in. to 2 in. with normal flow limits of 1 to 160 g. p. m.

Measuring chamber for the positive displacement disc is in two sections, held together by a snap joint without screws, which allows the case to separate without distortion if freezing occurs. Additional protection is afforded by the use, on the three smaller meters, of a cast-iron frost bottom, which will withstand all regular service pressures but will break if water in the meter freezes, thus relieving strain on the interior parts and avoiding damage to the meter. Replacement of the bottom at slight cost again fits the meter for service.

In the heavy register box, which has a double lid to facilitate cleaning the cover glass, is a train assembly of 4 cast bronze gears and four pinions, mounted on Monel



WORTHINGTON GA WATER METER

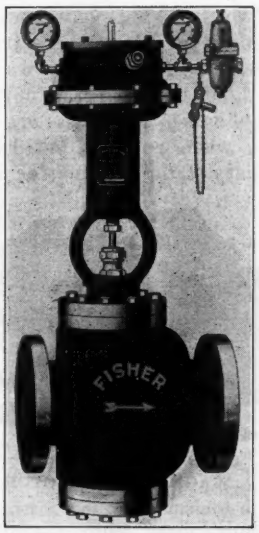
metal spindles and fitted with replaceable hard-rubber-bushed bearings. In standard construction, the gears are inclosed for oil but an open type can be substituted by removal of 3 screws.

As the stuffing box is cast on the main case, no gaskets or lock nuts are needed.

Accuracy is sufficient to record small drips and slow leaks which may cause an appreciable loss.

Wizard Pilot Unit

FISHER Governor Co., Marshalltown, Ia., announces Series 4200 unit, a design that includes the pilot valve as part of the main valve top. Air or gas may be used as operating medium, construction being suitable for pressures of 5 lb. or above. By a simple change in the pilot valve, the unit may be fitted for pressure relief or pressure reducing service. Pressure gages and a small auxiliary regulator are furnished as regular equipment.



By this design, time lag of pilot valve action is minimized so that the main valve quickly responds, thus maintaining close regulation limits.

New Copes Feedwater Regulator

THIS REGULATOR, type DA, developed by Northern Equipment Co., Erie, Pa., primarily for service on oil field boilers is applicable within certain limitations to other types of boilers where close control of flow through accurate valve port design is not required. It is a single unit, the valve installed only in a vertical feed line and no brackets or supporting members other than the ¾-in. steam and water connections being needed.

Movement of the tube acts directly on the valve stem to move the disc, without intermediate leverage. The expansion tube is in tension and is protected throughout its length by heavy channel irons se-

COPES DA REGULATOR

curely bolted to the valve body. A heavy spring at the heel piece end acts as a tension relief.

This regulator feeds continuously through a valve with stainless steel disc and seat, acting as check valve as well as regulating valve. A 2-in. valve of cast-iron or cast-steel is furnished complete with 250-lb. pressure standard companion flanges. If the valve is to be installed in a smaller feed line, companion flanges of the proper size are furnished. The regulator has a maximum capacity of 20,000 lb. per hour with a 15-lb. pressure drop across the valve.

Faucet for Heavy Mixtures

FOR EXTRACTING plastic compounds, cement and other slow-flowing mixtures from bulk containers, without removing the drum head,

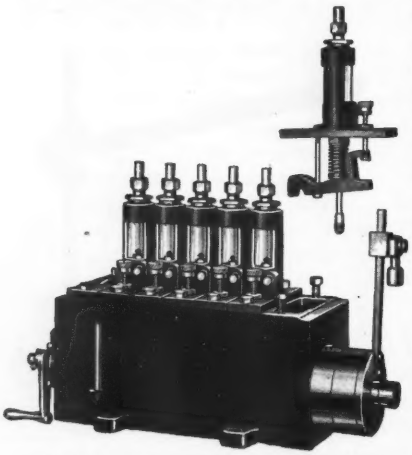
LE MAY FORCED FEED FAUCET

the Le May forced feed faucet provides a smooth, even flow as the crank-driven worm is turned. It also keeps the material mixed to an even consistency. Screw end is pro-

vided to fit a standard 1½-in. pipe opening. This faucet is introduced by the Key Boiler Equipment Co., E. St. Louis, Ill.

New Force Feed Lubricator

THIS LUBRICATOR has liquid filled sight glasses, and a single plunger to serve the dual purpose of drawing the oil from the reservoir and forcing it in a straight vertical path through the sight glass, then to the point of lubrication at the end of

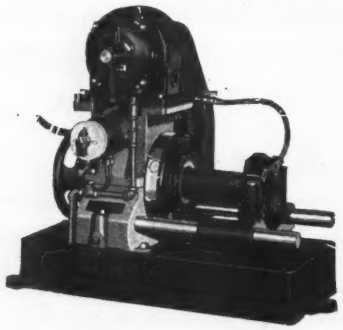


BOWSER MULTIFEED LUBRICATOR

the feed line. Each pumping unit is individually adjusted and removable while the lubricator is in operation. For refilling the sight glasses, a standard lubrication fitting permits injection of liquid by means of a grease gun. Any number of feeds and any type of driving mechanism required can be furnished.

Portable Pipe Machine

REGULAR capacity of this new Tom Thumb machine made by Oster Manufacturing Co., Cleveland, Ohio, includes pipe sizes from ½-in. to 2-in., with extra capacity down to ¼-in. It is furnished either with an



TOM THUMB PORTABLE PIPE MACHINE

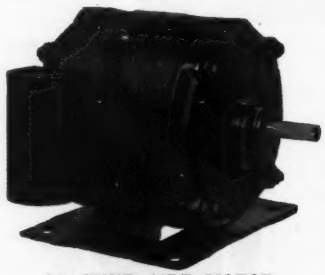
oil pump as shown below the motor at the front in the illustration, or without the pump, the dies being oiled by hand.

Dies are of the segment type, each size being held solid in a holder which is slipped over two vertical studs on the carriage. Pipe cutoff attachment can be omitted or furnished. In the latter case, the die head is swung out of the way when cutting off, to give room for the pipe.

Drive is by a VV belt from the motor to a spiral micarta pinion, thence to a spiral gear on the worm shaft, which carries a triple-thread worm mounted on Timken bearings. On the front end of the spindle is a quick-acting, 3-jaw, universal scroll type chuck, while, at the rear end is a 3-jaw universal centering chuck, operated by a hand wheel. Motor is universal, variable speed and reversible for attachment to an ordinary light socket.

Split-Phase Motor

TWO NEW split-phase motors are presented by Wagner Electric Co., the 44RB, illustrated in sizes 1/30 and 1/20 hp., and the 56RB for ⅛, 1/6 and ¼ hp. These are single-phase when running but have an auxiliary stator winding for produc-



WAGNER 44RB MOTOR

ing split-phase when starting, approximating the action of 2-phase squirrel-cage motors. At speed the redesigned switching mechanism cuts out the auxiliary winding. Other new features are end plates designed to prevent all drip and a conduit box adjustable in four positions. Special attention has been given to securing cool, vibrationless operation.

PYLE-NATIONAL Co. has acquired as a subsidiary to its organization The Electro Chemical Engineering Corp. which manufactures Signal Foam-Meters with electromatic blow-off and boiler corrosion prevention equipment.

A.S.R.E. To Meet in Cambridge at M.I.T.

THE AMERICAN SOCIETY of Refrigerating Engineers will hold its 19th Spring Meeting, June 9, 10 and 11 in Cambridge, Mass., with headquarters at the Massachusetts Institute of Technology. Members attending this meeting may secure dormitory quarters at M. I. T. at one dollar a day, and food and entertainment will be correspondingly priced. Those who bring their wives will be given special rates at the Copley-Plaza.

One of the social events arranged for is an all-day boat trip on Friday to Provincetown, with the morning session on the boat, luncheon and dinner at the Provincetown Inn, and the afternoon free for any of the many attractions of the historic Cape town with its famous artistic and literary colony.

Papers to be presented on the technical program are as follows: "Steam Ejector for Large Capacities", D. K. Dean, Foster-Wheeler Co.; "Mercury Ejector Refrigerator", L. F. Whitney, Comstock and Westcott; "Steam Ejector for Passenger Cars", R. W. Waterfill, Carrier Engineering Corp.; "Review of Heat Transmission Developments", W. J. King, General Electric Co.; "Mechanism of Moisture Absorption in Cold Storage Insulation", A. A. Berestneff, Massachusetts Institute of Technology; "Climate in the United States", O. W. Armspatch; "Economical Low Temperature and the Rotary Compressor", Harry Sloan, Vilter Mfg. Co.; "Lubrication", B. L. Newkirk, General Electric Co.; "Solid CO_2 Refrigeration Control", J. G. Bergdoll and A. W. Ruff, York Ice Machinery Corp.

A. L. Stevenson, Jr., of the General Electric Co. is chairman of the program committee arranging the technical sessions, and the entertainment has been planned by members of the Boston Section of the A.S.R.E., with Everett L. Ryan in charge.

SINCLAIR REFINING Co. has placed an order with The Neckar Co., Inc., for the installation of its process of boiler feedwater treatment in the Coffeyville, Kansas refinery, to treat 317,000 lb. of raw water an hour.

News From the Field

COMBUSTION Engineering Corporation announces the receipt of contracts from the Jamistown Coal and Coke Co. of Hannastown, Penna., for 3 stoker-fired boiler units, rated at 490 hp. each, of the C-E bent-tube type; stokers are forced-draft, chain-grate, having 130 sq. ft. grate each. Also from the Sinclair Refining Co. for a 615-hp. Walsh-Weidner sectional header boiler, for 450 lb. pressure, oil fired, of welded construction throughout, to be installed at the Coffeyville, Kansas, plant.

THE PARDEE ENGINEERING Co., 3915-29th St., Long Island City, N. Y., announce the appointment of the Hayes Pump & Machinery Co., of Boston, Mass., to represent them in the sales and service of the Pardee chlorinators and ammoniators in the New England States.

H. W. FULLER, vice president in charge of engineering and construction, Byllesby Engineering and Management Corp., announces the appointment of H. H. Watson as general superintendent of construction, Northen States Power Co., to be located in Minneapolis. Mr. Watson for the past 10 yrs. has been in charge of the special construction department of San Diego Consolidated Gas and Electric Co. Announcement also is made that George F. Pythian, who for several years has been in charge of construction work of The California Oregon Power Co. and Mountain States Power Co. will extend his duties to include the San Diego Consolidated Gas and Electric Co.

WALTER CABOT BAYLIES has been elected president of the Edison Electric Illuminating Co. of Boston to succeed the late Charles L. Edgar. Mr. Baylies, who is 70 yr. old, has been active in the development of the Massachusetts Gas Companies and the Edison Company. For 32 yr. he has been chairman of the executive committee of the latter. He is also a member of various boards of directors of numerous banks, industrial organizations and public utilities.

HARTFORD Steam Boiler Inspection and Insurance Co., Hartford, Conn., announces that it is now at home in its new building at 56 Prospect St., Hartford, Conn.

BESIDES representing Ernst & Co., Newark, N. J., Johnson and Kuechler, Inc., 30 Church St., New York City, announce that they are representing Freeman Boiler & Engineering Co. and The Superheater Co. as to superheaters for return tubular boilers.

FARVAL CORPN., Cleveland, Ohio, has acquired manufacturing and sales rights for the Farval centralized system of lubrication heretofore manufactured by Lubrication Devices, Inc., of Battle Creek, Mich. Officials of the new corporation are: Howard Dingle, president; W. W. Clark, vice-president; H. C. Robinson, treasurer; A. C. Blair, secretary; A. J. Jennings, general sales manager.

Distribution for the central industrial section will be by the Dingle-Clark Co. with offices in Cleveland, Cincinnati, Pittsburgh and Philadelphia.

ELECTRO-TECHNICAL CONGRESS of South America, which was to be held in Buenos Aires in July of this year, has been postponed by the executive committee, for various reasons, until April, 1933.

NEW ORDERS for steel boilers, based on reports of 72 manufacturers, are given by the Bureau of the Census for March, 1932, as 264 boilers of 372,782 sq. ft. heating surface. Of these 253 were stationary boilers as follows: 45 water tube, 234,822 sq. ft.; 18 h. r. t., 23,590 sq. ft.; 29 vert. fire tube, 6755 sq. ft.; 9 locomotive (not railway), 7230 sq. ft.; 131 steel heating (not power), 54,889 sq. ft.; 18 self-contained portable, 16,567 sq. ft., 3 miscellaneous, 585 sq. ft.

OIL BURNER orders for March, 1932, totaled 4055 according to data received by the Bureau of the Census from 103 manufacturers. Of these, 2766 were domestic mechanical draft burners, 682 domestic natural draft burners, 443 industrial mechanical draft burners and 164 industrial natural draft burners.

AIR CONDITIONING equipment data, presented as value of orders booked, are given for March, 1932, in preliminary form, by the Bureau of the Census, as reported by 41 manufacturers. Total for March was $690,657, sub-divided as follows: fan group, $385,199; unit heater group, $238,742; air washer group, $66,-716.

ORGANIZATION of an Air Conditioning Department within the General Electric Co., which will market various electrical devices for home heating, humidifying and temperature control, has been announced by President Gerard Swope. One of the first products to be marketed by this new department will be a complete oil burning furnace. J. J. Donovan, of Cleveland, formerly in charge of apartment house refrigeration sales, will be manager. Associated with him will be E. D. Harrington, of Schenectady, in charge of application engineering; J. R. Rue, of Pittsfield, in charge of manufacturing, and H. S. Woodruff, of Schenectady, in charge of design engineering. Headquarters will be maintained at General Electric's New York offices, 120 Broadway.

HOWARD J. BUTLER, for the past 7 yr. manager of the Citizens Power and Light Co. in Council Bluffs, Iowa, has resigned, it has been announced by Frank F. Everett, president of the company. Ill health necessitated Mr. Butler's resignation and he will take a long vacation before entering a new line of business. Vern Beats has been named acting manager and R. C. Geppert, general superintendent of the company. Mr. Beats was employed by the Council Bluffs utility in 1917 and in 1927 he was transferred to the Nebraska Power Co. as sales manager of the southern territory of the rural division. The appointment of Mr. Geppert, who is general superintendent of the Nebraska Power company, gives him supervision of both utilities. He has been assistant manager of the Citizens Power and Light from 1925-28 and became general superintendent of the Nebraska Power in 1930.

BAILEY METER Three-Element Feed Water Control will be displayed in spaces 401 to 405 at the National Electric Light Association exhibit June 5 to 10 at Atlantic City, N. J. This control which maintains the feed water flow equal to the steam flow from the boiler at all times will be shown by diagrammatic illustrations, photographs of installations and chart records of operation. Bailey Meter Automatic Combustion Control will also be shown by diagrammatic pictorial layouts. H. M. Hammond, manager sales and engineering, will be in charge.

MERCON REGULATOR Co. announces the appointment of new district representatives as follows: E. F. Espenschied, 1008 Hill Bldg., Washington, D. C.; M. N. Dannenbaum, 709 Bankers Mortgage Bldg., Houston, Texas; Cowles & Co., 721 Mercantile Bank Bldg., Dallas, Texas; Boiler Equipment Service Co., 686 Greenwood Avenue, Atlanta, Ga.; Cothran-Bayles Co., Commercial Bank Bldg., Charlotte, N. C.

GLEN E. BOWEN, formerly sales engineer for the Fulton Iron Works Co., has joined the sales organization of the Double Seal Ring Co., as announced by M. L. Munday, sales manager. Mr. Bowen is in charge of the Chicago territory, comprising Indiana, Illinois and Wisconsin, with office at 915 Glengyle Place, Chicago, Ill.

POOLE FOUNDRY & Machine Co., Woodberry, Baltimore, Md., has taken over the business of the former Poole Engineering & Machine Co. Officers are: S. P. Brady, president; S. P. Brady, Jr., vice-president; L. M. Ricketts, secretary and treasurer.

GEORGE L. HURST, consulting mechanical engineer, of San Francisco, is now handling the Farrel-Sykes products in the San Francisco territory. Mr. Hurst has been a representative of the Farrel-Birmingham Co. of Ansonia, Conn., and one of its predecessor units, the Birmingham Iron Foundry. of Derby, Conn., for a number of years. He maintains offices at 785 Market Street, San Francisco.

J. R. BROWN has been appointed sales representative for the Farrel-Birmingham Co., Inc., Ansonia, Conn. His headquarters are at the company's branch office, 2710 First Central Trust Building, Akron, Ohio.

LINDE AIR PRODUCTS Co. announces that both the Oxweld No. 14 drawn aluminum rod for welding sheet aluminum and the Oxweld No. 23 aluminum rod for welding cast and sheet aluminum and aluminum alloys are now available in the form of 10-lb. coils of ⅛-in. diameter rod, as many users have found the coil form advantageous for certain work.

D. H. SKEEN and Co. of Chicago has been appointed by Bonney Forge and Tool Works, Allentown, Pa., for welding fittings in the Chicago district.

HOMESTEAD Valve Manufacturing Co. has just appointed the Lietz Engineering Co., of 2354 Lincoln Avenue, as exclusive representative in the Chicago district.

For the Engineer's Library

THE HOLDING COMPANY. By James C. Bonbright and Gardner C. Means. Published by the McGraw-Hill Book Co., Inc., New York, N. Y.; 6 by 9 in., cloth; 384 pages; price, $4.00.

Within the last few years control and management of local utility companies have become centralized through a few great holding companies. This movement has not been restricted to the utility field but is a dominant factor in the steel, railway and banking industries as well.

This book gives a detailed and clearly presented review of the holding company, its history, significance, advantages and disadvantages as an institution and as an alternative to other forms of combination.

Inasmuch as the authors are primarily interested in regulation of utilities they have expressed definite convictions as to regulatory methods in this field while the industrial and banking holding company has been touched upon only for its influence on the holding company development.

Some 222 pages are devoted entirely to the utility company. This includes a chapter on the organization of the major systems. About 100 pages are devoted to the railway holding company and 17 to the bank holding company. A comprehensive appendix by Maurice Mound gives a short history of suits between minority and majority stock holders while a comprehensive list of books, articles and official documents on the subject of holding companies adds to its usefulness.

THE ECONOMICS OF PUBLIC UTILITIES. By L. R. Nash. Published by the McGraw-Hill Book Co., New York, N. Y.; 486 pages, 6 by 9 in., cloth; price, $4.00.

A comprehensive reference book for executives, engineers, students, inventors and others interested in the operation, management or regulation of the public utility company. Although written by a utility man from the utility standpoint the author has presented an obviously unbiased discussion which touches on all phases of the industry.

Among the 28 chapters are covered the history and characteristics of the public utility, franchises, accounting methods, capitalization, valuation and depreciation. Regulation, rate structures, taxation and securities are discussed in some detail along with public relations, public ownership and comment on current utility problems and issues.

The only menace to continued utility progress lies, in the author's opinion, in unwarranted political attacks. The industry should welcome criticism and eliminate practices not consistent with the highest standards of business ethics but should resent and publically condemn attacks on matters about which it has earned the right to freedom from criticism.

FIFTY YEARS of New York Steam Service is the title of a handsome and interesting book of 130 pages issued by New York Steam Corp. on the 50th Anniversary of its inception. It shows clearly the progress of central heating and steam supply, keeping step with the growth of the city, and the courage of the management in overcoming obstacles up to the present dominant position as an outstanding public utility service. While the book is not intended for general distribution, a few copies are available for those especially interested in central heating and the work of the Corporation. Requests should be made to A. R. Heath, executive assistant, New York Steam Corp., 280 Madison Ave., New York, N. Y.

TIMKEN Wear and Lubricant Tester, a new development of the Timken Roller Bearing Co., Canton, Ohio, is described and illustrated, its principle and the details of construction and action explained in an interesting bulletin recently issued by that company.

HERRINGBONE Reduction Gears, high-speed type, designed for drives where silence is a factor, such as generator, pump and blower units having turbine motor or oil engine drive are completely described and illustrated in Bulletin T-111 just published by Murray Iron Works Co., Burlington, Iowa.

FRANKLIN coal burner, a motor-driven underfeed stoker with forced draft for heating installations is described in an illustrated leaflet issued by Columbus Auto Brass Co., Columbus, Ohio.

WELDED ICE CANS as made by the Frick Co. of Waynesboro, Pa., are described in Bulletin 162-A issued by that company.

Advantages of welded construction are shown, the details of improved construction that are made possible by the process, tests to which the cans are subjected, and the advantages of the cans in convenience and durability.

NEW CATALOG No. 5 covering air circuit breakers, both open and enclosed; attachments and accessories of all kinds; relays and sectional steel, dead-front switchboards and cubicles has been issued by the Roller-Smith Co., 233 Broadway, New York City. On Page 15 of this catalog appears an illustration and a description of a new product, sectional steel, dead-front switchboards and cubicles, developed to meet the demand for control equipment of the dead-front type.

FOLDER entitled, The Beco-Turner Baffle Wall has just been issued by the Boiler Engineering Co., 744 Broad St., Newark, N. J. This folder is designed to show clearly how water tube boilers should not be baffled and how they should be baffled. It includes numerous examples of how boiler efficiency and capacity have been increased by proper baffling. Photographs of actual installations on all kinds of water tube boilers — horizontal and vertical—are reproduced. A set of operating charts show temperature readings with correct and incorrect baffling.

WONDER BOOK of Rubber is the title of a new illustrated bulletin published by the B. F. Goodrich Co., Akron, Ohio. It is not offered as a scientific discussion but rather as a story of rubber and the manufacture and use of rubber products. Characteristics of rubber are discussed, details are given of the manufacture of various rubber products and many interesting illustrations show how rubber is applied in industry.

BULLETIN 1024 on a Tag steam-operated controller is issued by C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y.

BULLETIN No. 70 of Fisher Governor Co., Marshalltown, Ia., describes and illustrates Series 4000 auxiliary actuated pressure controllers, including the Wizard pilot. Applications are shown and list given of pipe sizes, dimensions of units and prices.

FOLDER 232 of the Borden Co., Warren, Ohio, shows Beaver pipe tools for hand operation, the Beaver pipe machine and power drives. Net prices are given for delivery anywhere in the United States.

PIPING AND VALVES, including welded and standard bolted types, in all forms such as flanges, gate valves, companion joints, butterfly valves, cooling coils and similar equipment are completely described and illustrated in Bulletin 44 just issued by Semet-Solvay Engineering Corp., 40 Rector St., New York. The company is also issuing Bulletin No. 45 on the Semet-Solvay Koller type gas producer.

MECHANICAL RELIABILITY of Hydroelectric Units—1930 has just been issued as Publication No. 216 by the Hydraulic Power Committee, National Electric Light Association, 420 Lexington Ave., New York, price 25 cents to members, 40 cents to non-members.

In this report, outage records of 230 units, covering a wide range of head and capacity, have been classified according to the type of turbine and the cause of the outage. Data on reliability are tabulated and presented graphically to show trends and to make comparisons of performance of steam and hydroelectric units.

UNIT HEATERS, their design, construction and operation, are discussed in detail in a new bulletin by McCord Radiator & Mfg. Co., Detroit, Mich.

COMBUSTION Engineering Corp., 200 Madison Avenue, New York, has available for distribution copies of three articles, namely Tangential Firing of Gaseous and Liquid Fuels, Corner-Firing of Blast Furnace Gas and Combination Burning of Blast Furnace Gas and Pulverized Fuel, in which are discussed the recent developments in methods of firing and in furnace design, which are being successfully applied for burning gaseous and liquid fuels, either singly or in combination with pulverized fuel. Several installations are described and data given on operation. 8 pages each. 8½x11 in.

WESTINGHOUSE O C Watthour single phase meters are described in a recent bulletin published by the Newark works of the Westinghouse Electric and Manufacturing Co.

THE HOLT Automatic Strainer is described in Bulletin No. 20 just issued by Rosedale Foundry and Machine Co. of Pittsburgh, Pa. These strainers are for the protection of water supply lines and are extremely easy to keep clean.

BROOKS OIL Co., Cleveland, Ohio, is issuing an interesting booklet on Brooks Improved Boiler Metal Treatment describing how it works.

A FOLDER just received from Brooks Oil Co., Cleveland, Ohio, gives the fundamentals of its Boiler Metal Treatment, method of use and results accomplished in prevention of corrosion and scale adherence.

Power Plant Construction News

Ala., Montgomery—Montgomery Stave & Cooperage Co., North McDonough Street, plans installation of power equipment in connection with proposed rebuilding of portion of mill, recently destroyed by fire with loss of about $75,000.

Calif., Escondido—Union Ice Co., 1315 East Seventh Street, Los Angeles, Calif., is considering construction of one-story ice-manufacturing plant at Second Avenue and Spruce Street, Escondido, reported to cost over $30,000, with equipment.

Calif., Oakdale—Oakdale Irrigation District, Oakdale, is planning installation of a pumping plant in Lone Tree Creek district for water supply service. Estimates of cost, including list of equipment, will soon be made.

Calif., Pasadena—City Light Department has plans nearing completion for a new equipment storage, distributing and repair plant on Glen Street, consisting of three one-story structures, 63 by 221 ft., 33 by 87 ft., and 33 by 89 ft. Last noted will be used for repair of transformers and other equipment. Plant is reported to cost over $85,000. Marston & Maybury, 25 South Euclid Avenue, are architects.

Del., Dover—City Council is considering installation of additional equipment in municipal electric light and power plant, including turbine unit with accessories. Estimated cost $43,000. L. D. Shank is city manager.

Fla., Goulding—Southern Cotton Oil Co., Canal Bank Building, New Orleans, La., plans installation of motors and other power equipment in connection with proposed rebuilding of mill at Goulding, recently destroyed by fire with loss over $100,000.

Ga., Atlanta—Knight Ice Co., Atlanta, has plans for a one-story ice-manufacturing plant, about 65 by 85 ft., on McDaniel Street, reported to cost about $25,000, with machinery. George Brungart, Jr., Jonesboro Road, is engineer, in charge.

Ill., Springfield—City Council plans early call for bids for an addition to municipal electric light and power plant, with improvements in present unit, including installation of boilers and accessories, condenser and auxiliary equipment. Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., is consulting engineer.

Ind., Greencastle—Board of Trustees, DePauw University, has revised plans under way for extensions and improvements in central steam power plant for heating service, including one-story addition, 40 by 60 ft. Installation will include boiler, pumping units, coal and ash-handling equipment and accessories, with new 130-ft. steel stack.

Ind., Vincennes—Genoa Paper Box Co., Genoa, Ill., H. L. Brenbarger, head, plans installation of motors and other electric power equipment in proposed new plant at Vincennes, where factory building has been leased. Present plant will be removed to new location and capacity increased.

Iowa, Croton—Illinois-Iowa Bridge Co., Keokuk, Iowa, Robert W. Curtis, engineer, will have early hearing on application to Federal Power Commission to construct and operate a power dam and hydroelectric generating plant on Des Moines River, near Croton. A transmission line will be built. Entire project reported to cost over $500,000.

Iowa, Cedar Rapids—Iowa Electric Co., Cedar Rapids, has made application for permission to construct new transmission lines in Scott and Jackson Counties. Estimated cost not announced.

Kan., Topeka—Department of Public Works is considering installation of new motor-driven pumping unit, capacity about 4000 g. p. m., and auxiliary equipment in pumping plant at North Topeka, for waterworks service. New pump will replace two old units. W. E. Baldry is engineer.

Md., Baltimore—Susquehanna Transmission Co., Lexington Building, Baltimore, operated by Pennsylvania Water & Power Co., same address, has secured permission for construction of a new steel tower transmission line from point on Pennsylvania state line, near Conowingo Creek, to Perryville, Md., passing through Cecil County, for power service for new electrified line of Pennsylvania Railroad Co., now being built. Power line will connect with hydroelectric generating plant of Safe Harbor Water Power Co., Safe Harbor, Pa., an affiliated interest.

Md., Hooper's Island—South Dorchester Electric Light & Power Co., care of George W. Lindsay, 2036 Baltimore Trust Building, Baltimore, Md., recently organized, plans construction of a power plant on Hoopers Island, with transmission line to end of island and other neighboring points. An ice-manufacturing plant with capacity of 20 tons per day is also planned. Permission has been granted by Public Service Commission.

Mich., Grand Rapids—Water Department, engineering division, has plans under way for a steel standpipe and reservoir for municipal water system, on site on Fuller Avenue, to provide capacity of 1,500,000 gal.

Minn., Hutchinson—Common Council is considering a municipal electric light and power plant, reported to cost close to $100,000, with equipment. D. A. Adams is city clerk.

Minn., Morris—Common Council has engaged Robert J. Torrens, Shubert Building, St. Paul, Minn., consulting engineer, to prepare plans for proposed municipal electric light and power plant, estimated to cost about $150,000, with equipment. J. A. Mielke is town clerk.

Mo., St. Charles—City Council is considering a report of Russell & Axon, Roosevelt Building, St. Louis, Mo., consulting engineers, for a proposed municipal electric lighting plant and distributing system. Dr. L. E. Belding is chairman of committee in charge. Project reported to cost more than $150,000.

Neb., St. Edward—Common Council is having plans completed for a municipal electric light and power plant, reported to cost over $50,000, with equipment. C. V. Barnhill, Federal Trust Building, Lincoln, Neb., is architect.

N. J., Perth Amboy—Raritan Copper Works, Elm and Market Streets, plans rebuilding of power house at local mill, recently damaged by fire with loss reported over $40,000, including equipment.

Ohio, Roseville—Village Council is said to be planning installation of pumping machinery and auxiliary equipment in connection with proposed municipal waterworks. A bond issue of $40,000 has been arranged for the work.

Ohio, Van Wert—Stoops Packing Co., James Stoops, president, plans installation of electric power equipment in new vegetable canning and packing plant, to replace factory recently destroyed by fire. Cost estimated at close to $90,000.

Okla., Ada—J. A. McCurley, El Reno, Okla., is considering construction of a new one-story ice-manufacturing plant at Ada, about 45 by 60 ft., with capacity of about 20 tons per day. Estimated to cost about $25,000, with equipment.

Okla., Idabel—Common Council is considering construction of a municipal electric light and power plant, estimated to cost about $90,000, with equipment. F. D. Taffee, Idabel, is engineer.

Ont., Campbellford—Hydro-Electric Power Commission, Campbellford, plans installation of electric power equipment in connection with proposed rebuilding of local pulp mill, recently destroyed by fire with loss estimated over $100,000.

Pa., Pittsburgh—Chief of Engineers, Washington, D. C., has recommended construction of two new locks and dams on Allegheny River, to replace present structures at Aspinwall and Springdale, with power plants, electric lock-operating machinery and other equipment. Project is estimated to cost $4,906,000 and appropriation is being asked. United States Engineer Office, Pittsburgh, will be in charge.

S. D., Hot Springs—Interstate Oil & Refining Co., Hot Springs, has plans in progress for a Diesel engine generating plant at properties in the Mule Creek district, and plans early construction. Estimated cost not announced.

S. D., Sioux Falls—General Manganese Corp., 155 West Congress Street, Detroit, Mich., plans installation of electric power equipment in new leaching and concentrating mill on 50-acre tract of land near Sioux Falls, on which options have been secured. A power house is projected. Entire plant is estimated to cost close to $350,000, with machinery.

Texas, San Antonio—S. E. Knowlton Creamery Co., 1415 West Summit Avenue, plans installation of electric power equipment in new two-story creamery and milk plant on Fredericksburg Road, Martinez Creek district, entire project estimated to cost about $55,000. Harrington Co., Builders' Exchange Building, is architect.

Utah, Brigham—Utah Gold Milling & Mining Co., care of F. W. McEntire, 155 Second Avenue, Salt Lake City, Utah, engineer, plans installation of electric power equipment in new ore mill in Park Valley district, near Brigham, entire project reported to cost close to $70,000.

Machinery, Equipment and Supplies Used In The Production, Transmission and Utilization of Power

Under the heading of each product listed will be found the names of the manufacturers of that product. The index to advertisers, next to the back cover, gives the page numbers on which the manufacturers' descriptive advertisements appear

Air Compressors
De Laval Steam Turbine Co.
General Elec. Co.
Worthington Pump and Machy. Corp.

Air Preheaters
Air Preheater Corp.
Babcock & Wilcox Co.
Combustion Engrg. Corp.
Edge Moor Iron Co.

Air Seals, Kiln
Edge Moor Iron Co.

Ash Handling Systems
Combustion Engrg. Corp.

Belt Dressing
Dixon Crucible Co., Jos.

Blowers, Fan and Furnace
Air Preheater Corp.
Carling Turbine Blower Co.
De Laval Steam Turbine Co.
Wing Mfg. Co., L. J.

Blowers, Forced Draft, Portable, Pressure and Pulverized Coal
Carling Turbine Blower Co.
Ideal Commutator Dresser Co.
Wing Mfg. Co., L. J.

Blowers, Tube
Diamond Power Spec. Corp.

Blowers, Turbine
Carling Turbine Blower Co.
Elliott Co.
Moore Steam Turbine Corp.
Terry Steam Turbine Co.
Wing Mfg. Co., L. J.

Boiler Baffles
Engineer Co., The

Boiler Blow Down Systems
National Aluminate Corp.

Boiler Compounds
Dearborn Chemical Co.

Boiler Setting Cement
Hays Corp.

Boiler Settings
Engineer Co., The

Boiler Tube Cleaners
Liberty Mfg. Co.
Pierce Co., Wm. B.
Roto Co., The

Boilers, Power and Heating
Babcock & Wilcox Co.
Combustion Engrg. Corp.
Edge Moor Iron Co.
Springfield Boiler Co.
Vogt Machine Co., Inc.

Boilers, Waste Heat
Babcock & Wilcox Co.
Edge Moor Iron Co.

Brushes, Graphite, Dynamo & Motor
Dixon Crucible Co., Jos.

Bucket Elevators
Kennedy-Van Saun Mfg. & Engrg. Corp.

Bunkers, Coal & Ash
Kennedy-Van Saun Mfg. & Engrg. Corp.

Castings, Steel
Springfield Boiler Co.

Cement, Iron
Smooth-On Mfg. Co.

Cement, Refractory, Acid Proof, Furnace and High Temp.
Babcock & Wilcox Co.

Chain Wheels
Babbitt Steam Spec. Co.

Chemicals, Water Treating
National Aluminate Corp.

Chimneys
American Chimney Corp.

Cleaning Compound
Dearborn Chem. Co.

Coal Carbonizing Apparatus
Combustion Engrg. Corp.

Coal Crushers
Kennedy-Van Saun Mfg. & Engrg. Corp.

Cocks, Air and Steam
Dart Mfg. Co., E. M.
Lonergan Co., J. E.
Lunkenheimer Co.
Williams Valve Co., D. T.

Coils and Bends
Midwest Piping & Supply Co.
National Pipe Bend. Co.

Combustion (CO_2) Recorders
Brown Inst. Co.
Hays Corp.
Pierce Co., Wm. B.

Combustion Control System
Bailey Meter Co.
Engineer Co., The
Hagan Corp.
Hays Corp.

Combustion Engineers
Engineer Co., The
Hagan Corp.

Commutator Cement
Ideal Commutator Dresser Co.

Commutator Dressers, Slotters, Stones
Ideal Commutator Dresser Co.

Compound Pipe Joint
Dixon Crucible Co., Jos.
Smooth-On Mfg. Co.

Condenser Tube Cleaners
Pierce Co., Wm. B.
Roto Co., The

Condensers
Allis-Chalmers Mfg. Co.
Elliott Co.
Frick Co.
Worthington Pump and Machy. Corp.

Continuous Boiler Blow Off Systems
Cochrane Corp.

Conveyors
Kennedy-Van Saun Mfg. & Engrg. Corp.

Conveying Systems, Pneumatic
Kennedy-Van Saun Mfg. & Engrg. Corp.

Cooling Systems
Schubert-Christy Corp.
Yarnall-Waring Co.

Cooling Towers
Schubert-Christy Corp.

Counters, Revolution
Lonergan Co., J. E.

Couplings, Flexible
Terry Steam Turbine Co.

Couplings, Union
Dart Mfg. Co., E. M.

De-aerators
Cochrane Corp.
Elliott Co.

Dryers, Coal
Kennedy-Van Saun Mfg. & Engrg. Corp.

Economizers
Babcock & Wilcox Co.

Ejectors
Elliott Co.

Electrical Supplies
General Elec. Co.
Ideal Commutator Dresser Co.

Electrical Wires & Cables
General Elec. Co.

Engines, Oil, Gas and Gasoline
McIntosh & Seymour Corp.
Worthington Pump & Machy. Corp.

Engines, Steam
Allis-Chalmers Mfg. Co.
Elliott Co.
McIntosh & Seymour Corp.
Troy Eng. & Mach. Co.

Exhaust Heads
Burt Mfg. Co., The
Hoppes Mfg. Co.
Ruggles-Klingemann Mfg. Co.

Oil, Coal, Gas Burning Equipment
Combustion Engrg. Corp.
Engineer Co., The.

Fans, Airplane Type
Schubert-Christy Corp.

Fans, Electric
Carling Turbine Blower Co.

Fans, Exhaust and Ventilating
Wing Mfg. Co., L. J.

Feed Water Filters
Elgin Softener Corp.

Feed-Water Heaters and Purifiers
Cochrane Corp.
Elliott Company.
Hoppes Mfg. Co.
National Pipe Bend. Co.
Scaife & Sons Co., Wm. B.
Worthington Pump & Machy. Corp.

Feed Water Treatment
Dearborn Chemical Co.
Elgin Softener Corp.
Hagan Corp.
National Aluminate Corp.
Scaife & Sons Co., Wm. B.
Zeolite Chemical Co.

Filters, Oil
Burt Mfg. Co., The.

Filters, Water
Cochrane Corp.
Permutit Co.
Scaife & Sons Co., Wm. B.
Zeolite Chemical Co.

Fire Brick and Cement
Babcock & Wilcox Co.

Fire Hydrants
Kennedy Valve Mfg. Co.

Fittings, Flange and Pipe
Kennedy Valve Mfg. Co.

Flanges
Dart Mfg. Co., E. M.

Flooring, Open Steel
Dravo-Doyle Co.
Tri-Lok Co.

Flow Meters
Bailey Meter Co.
Brown Inst. Co.

Flue Cleaners
Diamond Power Spec. Corp.
Pierce Co., Wm. B.

Flue Gas Analysis Instruments
Hays Corp.

Furnace Fire Observers
Springfield Boiler Co.

Furnace Walls
Combustion Engrg. Corp.

Furnaces, Boiler
Kennedy-Van Saun Mfg. & Engrg. Corp.

Furnaces, Pulverized Coal
Kennedy-Van Saun Mfg. & Engrg. Corp.

Gas Collectors
Hays Corp.

Gaskets
Smooth-On Mfg. Co.

Gauge Cocks
Lonergan Co.

Gauges, Differential and U-Tube
Hays Corp.

Gauges, Draft, Liquid Level
Bailey Meter Co.
Brown Inst. Co., The.
Hays Corp.
Pierce Co., Wm. B.

Gauges, Pressure and Recording
Lonergan Co., J. E.

Gauges, Water
Lonergan Co., J. E.
Lunkenheimer Co.

Gears, Reduction and Double Helical
De Laval Steam Turbine Co.
Moore Steam Turbine Corp.
Terry Steam Turbine Co.

Generating Sets
Allis-Chalmers Mfg. Co.
Carling Turbine Blower Co.
Moore Steam Turbine Corp.
Terry Steam Turbine Co.
Troy Eng. & Mach. Co.

Generators, Electric
Allis-Chalmers Mfg. Co.
Elliott Co.
General Elec. Co.
Troy Eng. & Mach. Co.

Governors, Pump
Atlas Valve Co.
Chaplin-Fulton Mfg. Co.
Northern Equipment Co.
Squires Co., C. E.

Graphite
Dixon Crucible Co., Jos.

Grates and Grate Bars
Kelly Fdry. & Mach. Co.

Grating, Steel
Dravo-Doyle Co.
Tri-Lok Co.

Grease
Dearborn Chem. Co.
Dixon Crucible Co., Jos.
Vacuum Oil Co.

Heat Exchangers
Elgin Softener Corp.
National Pipe Bend. Co.
Vogt Machine Co., Henry

Heaters for Special Purposes
National Pipe Bend. Co.

Heaters, Bleeder and Hot Water
National Pipe Bend. Co.

Heaters, Oil
National Pipe Bend. Co.

Ice Making & Refrigerating Machinery
Vogt Machine Co., Henry.

Instruments, Electrical
General Elec. Co.

Insulating Material
General Elec. Co.

Joints, Expansion
Yarnall-Waring Co.

Ladder Steps, Steel
Dravo-Doyle Co.
Tri-Lok Co.

Lubricants
Dearborn Chem. Co.
Dixon Crucible Co., Jos.
Vacuum Oil Co.

Lubricators
Lunkenheimer Co.
Manzel Bros. Co.
Williams Valve Co., D. T.

Lubricators, Forced Feed
Manzel Bros. Co.

Mechanical Draft Apparatus
Wing Mfg. Co., S. J.

Meters, Air and Gas
Bailey Meter Co.

Meters, Boiler
Bailey Meter Co.
Brown Inst. Co., The.

Meters, Coal
Bailey Meter Co.

Meters, Water and Steam
Bailey Meter Co.
Brown Inst. Co., The.
Cochrane Corp.
Hoppes Mfg. Co.
Worthington Pump & Machy. Corp.

Meters, V-Notch
Cochrane Corp.
Yarnall-Waring Co.

Monel Metal Rings, Rods, Castings, Forgings, Tubing, Sheets, Wire and Wire Cloth
International Nickel Co.

Motors
Allis-Chalmers Mfg. Co.
General Elec. Co.

Nozzles for All Purposes
Yarnall-Waring Co.

Oil and Grease Cups
Keystone Lubricating Co.
Lonergan Co., J. E.
Lunkenheimer Co.
Williams Valve Co., D. T.

Oil Purifiers
De Laval Separator Co.
De Laval Steam Turbine Co.

Oil Separators
De Laval Separator Co.

Oil Tanks
Manzel Bros. Co.

Oiling Systems
Burt Mfg. Co., The.
De Laval Separator Co.

Oils, Lubricating
Dearborn Chemical Co.
Vacuum Oil Co.

Paint, Graphite
Dixon Crucible Co., Jos

Penstocks
Smith Co., S. Morgan

Pipe Bending
Midwest Piping & Supply Co.
National Pipe Bend. Co.
Pittsburgh Piping & Equip. Co.
Shaw-Kendall Engrg. Co.

Pipe Coils
Midwest Piping & Supply Co.
National Pipe Bend. Co.
Pittsburgh Piping & Equip. Co.
Shaw-Kendall Engrg. Co.
Vogt Machine Co., Inc.

Pipe Cutters
Toledo Pipe Threading Mach. Co.

Piping, Manufacturing, Fabricating & Contracting
Midwest Piping & Supply Co.
Pittsburgh Piping & Equip. Co.
Pope, Wm. A.
Shaw-Kendall Engrg. Co.

Preheaters
Babcock & Wilcox Co.

Pulverized Fuel Equipment
Combustion Engrg. Corp.
Kennedy-Van Saun Mfg. & Engrg. Corp.

Pulverizers, Coal and Stone
Kennedy-Van Saun Mfg. & Engrg. Corp.

Pumps, Boiler Feed
Allis-Chalmers Mfg. Co.
De Laval Steam Turbine Co.
Moore Steam Turbine Corp.
Worthington Pump & Machy. Corp.

Pumps, Centrifugal
Allis-Chalmers Mfg. Co.
De Laval Steam Turbine Co.
Moore Steam Turbine Corp.
Worthington Pump & Machy. Corp.

Pumps, Deep Well
Worthington Pump & Machy. Corp.

Pumps, Elevator, Fire and General Service
De Laval Steam Turbine Co.

Pumps, Oil and Electric
Lonergan Co., J. E.
Manzel Bros. Co.

Pumps, Power
Worthington Pump & Machy. Corp.

Pumps, Turbine
Moore Steam Turbine Corp.

Pumps, Waterworks
Moore Steam Turbine Corp.

Purifiers, Boiler Feed
Hoppes Mfg. Co.
Scaife & Sons Co., Wm. B.

Purifiers, Steam
Hagan Corp.

Pyrometers
Brown Inst. Co.

Recorders, Draft, Gravity
Hays Corp.

Recording Instruments
Hays Corp.

Regulators, Damper
Atlas Valve Co.
Brown Inst. Co., The.
Engineer Co., The.
Hagan Corp.
Hays Corp., The.
Ruggles - Klingemann Mfg. Co.
Sarco Co., Inc.

Regulator, Fan Engine
Atlas Valve Co.

Regulators, Feed Water
Atlas Valve Co.
Bailey Meter Co.
Chaplin-Fulton Mfg. Co.
Northern Equipment Co.
Ruggles - Klingemann Mfg. Co.
Sarco Co., Inc.
Squires Co., C. E.

Regulators, Pressure
Hagan Corp.
Northern Equipment Co.
Ruggles - Klingemann Mfg. Co.
Sarco Co., Inc.
Squires Co., C. E.

Regulators, Temperature
Atlas Valve Co.
Brown Inst. Co., The.
Ruggles - Klingemann Mfg. Co.
Sarco Co., Inc.